# Environmental Assessment
for

Golden Sunlight Mines,
Inc.
prepared by Montana
Dept. of State Lands

May 1989

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ENVIRONMENTAL ASSESSMENT

FOR

Golden Sunlight Mines, Inc.

prepared by
Montana Department of State Lands

May 1989

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CHAPTER I - INTRODUCTION

A. Background

Golden Sunlight Mines, Inc., (GSM) a wholly owned subsidiary of Placer Dome U.S. Inc. of San Francisco, California, is operating an open pit gold mine in Jefferson County, Montana (Figure 1). The permit was granted after distribution of an Environmental Impact Statement. Since issuance, six amendments have been approved. The original EIS and subsequent Preliminary Environmental Reviews written as a result of the amendment applications are incorporated by reference into this environmental assessment.

The present operating permit and amendments allow GSM to mine through Stage III (Figure 2) within a permit area of 4113 acres. When Stage III is completed in 1993, the pit would measure 140 acres, the waste rock dump 320 acres, and the tailings impoundment 198 acres. Approximately 20 million tons of ore (1.75 million tons annually), 20 million tons of tailings, and 90 million tons of waste rock (11.37 million tons annually), would be produced through Stage III. Ore is trucked from the pit to the mill where it is crushed and vat leached with sodium cyanide to extract gold. The leached waste material (tailings) is subsequently slurried to the tailings impoundment.

B. Summary of Proposed Amendment

Golden Sunlight Mine, Inc. proposes to expand mine production from Stage III to Stage V (Figure 3), extending the life of the operation to the year 2005. Mining through Stage V would produce 50 million tons of ore and 300 million tons of waste rock (Table 1). Expansion of the mine would create a pit approximately 190 acres in size, daylighting the east flank of the mountain at an elevation of 5,375 feet (Figure 4). A second tailings impoundment would be constructed east of the existing tailings impoundment to contain additional tailings. The impoundment would cover 250 acres and reach a height of 150 feet. The existing waste rock dumps would be expanded, covering approximately 691 acres. Dump expansion would occur to the northeast and southwest of the existing pit.

The mining, milling and metallurgical processes would not change. However, the second impoundment, unlike the first impoundment, would be constructed with a synthetic liner. Centerline construction of the embankment is proposed.

1. Location and Land Ownership

The permit area is located in portions of Section 19, 20, 29, 30 and 32 of Township 2 North, Range 3 West, MPM. Golden Sunlight controls the surface and mineral ownership of these lands by a combination of fee simple ownership, patented claims, and unpatented claims which the company either owns or leases. Lands owned by the State of Montana within the permit area have been exchanged for other lands owned by GSM. The state owned mineral lease area has been examined by condemnation drilling and the lease revoked, allowing GSM to propose to use the surface for waste in this amendment.

Figure 1 - General Location Map

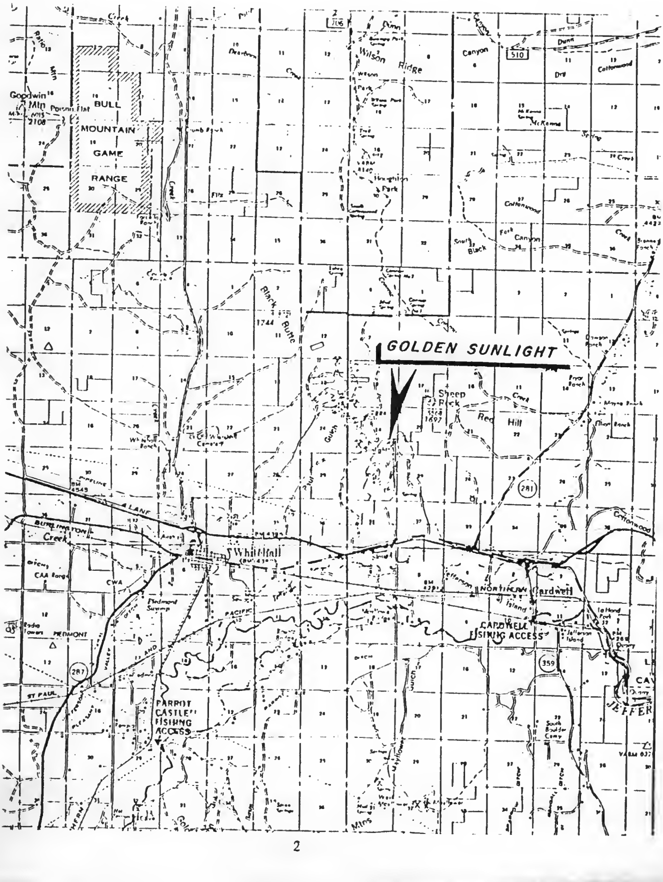

Figure 2 - Present Property Layout

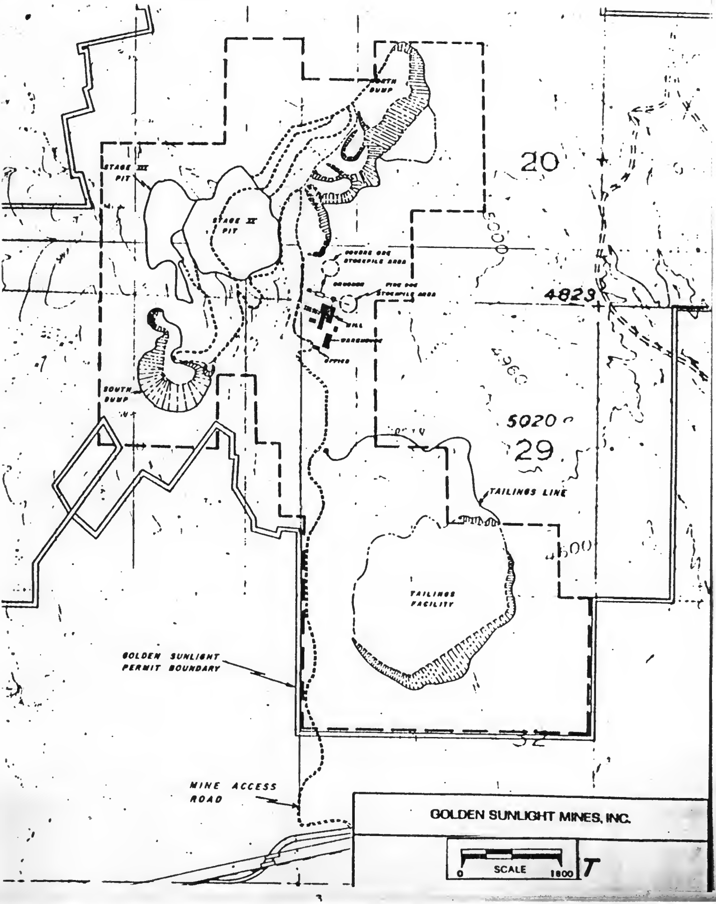

Figure 3 - Plan of Pit Stages

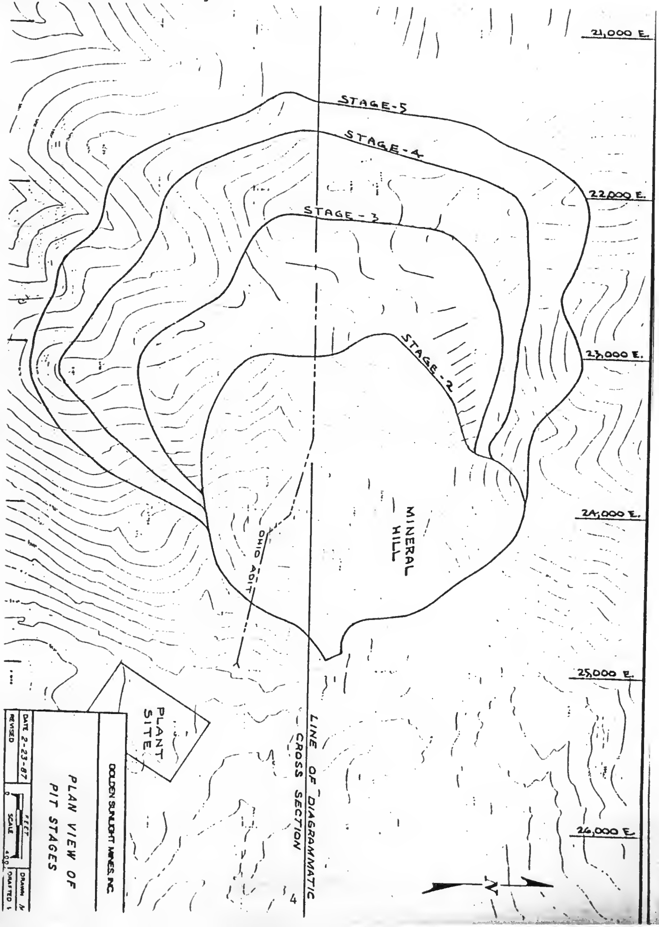

Table 1 - 1988 Proposed Mine Schedule

1988 Proposed Mine Schedule

Year	Stage 1 Tons x 1000			Stage 2 Tons x 1000			Stage 3 Tons x 1000			Stage 4 Tons x 1000			Stage 5 Tons x 1000			Tons x 1000		
	Bench	Ore	Waste	Bench	Ore	Waste	Bench	Ore	Waste	Bench	Ore	Waste	Bench	Ore	Waste	Total Ore	Total Waste	Strip Ratio
1987	5475-5450	663	100	5725-5625	1,785	4,719	6400-6167	---	7,146							2,448	11,965	4.9:1
1988				5625-5550	2,448	940	6167-5967	---	14,292							2,448	15,232	6.2:1
1989				5550-5475	2,448	391	5967-5800	---	14,292							2,448	14,583	6.0:1
1990				5475-5375	1,807	501	5800-5600	641	14,290	6400-6233	---	5,770				2,448	20,561	8.4:1
1991							5600-5500	2,448	3,008	6233-6000	---	23,079				2,448	26,087	10.7:1
1992							5500-5425	2,448	1,689	6000-5833	---	23,079				2,448	24,768	10.1:1
1993							5425-5350	2,448	1,586	5833-5650	---	23,077				2,448	24,663	10.1:1
1994							5350-5300	1,146	249	5650-5400	1,302	23,082				2,448	23,331	9.5:1
1995										5400-5325	2,448	4,206	6800-6000	---	20,575	2,448	24,781	10.1:1
1996										5325-5275	2,448	1,522	6000-5833	---	20,575	2,448	22,197	9.1:1
1997										5275-5225	2,448	1,143	5833-5700	---	20,575	2,448	21,718	8.9:1
1998										5225-5150	2,448	358	5700-5525	---	20,575	2,448	20,933	8.5:1
1999										5150-5050	2,210	89	5525-5325	238	20,566	2,448	20,655	8.4:1
2000													5325-5150	2,448	11,445	2,448	11,445	4.7:1
2001													5150-5075	2,448	2,543	2,448	2,543	1.0:1
2002													5075-5025	2,448	1,596	2,448	1,596	0.7:1
2003													5025-4950	2,448	1,012	2,448	1,012	0.4:1
2004													4950-4850	2,448	691	2,448	691	0.3:1
2005													4850-4800	434	50	434	50	0.1:1
Total		663	100		8,483	6,551		9,131	56,552		13,304	105,505		12,912	120,203	44,498	288,311	6.5:1

Figure 4 - Diagrammatic Cross Section

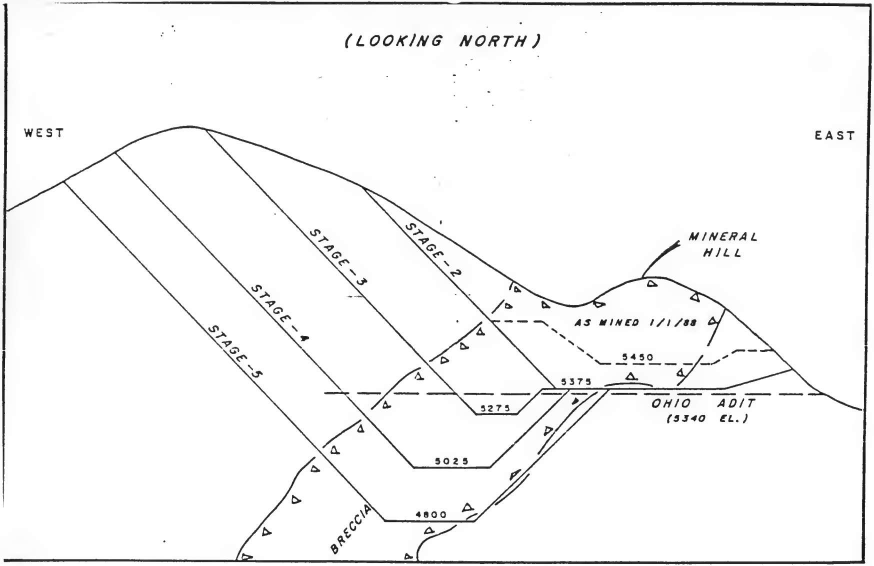

FIGURE: 4 DIAGRAMMATIC CROSS SECTION 26,000 N. SHOWING OPEN PIT MINING STAGES

C. Agency Roles and Responsibilities

1. Department of State Lands

The Commissioner of State Lands must decide whether to approve the project as applied for, approve modified plans, approve subject to stipulations, or deny the permit as required by the Montana Metal Mine Reclamation Act (MMRA).

DSL administers MMRA. The purpose of the act is to recognize and protect the usefulness, productivity and scenic values of the lands and waters within the state and to reclaim to beneficial use the lands used for mining. The act and its regulations (ARM 26.4.101 et seq.) set forth the steps to be taken in the issuance of an operating permit for and the reclamation of the applicant's proposed mine expansion. The act applies to all lands within Montana.

DSL's rules (ARM 26.2.601 et seq.) implementing the Montana Environmental Policy Act (MEPA) (Title 75, Chapter 1, MCA) also require preparation of an Environmental Assessment. The Environmental Assessment (EA) has several purposes:

1. It serves to ensure that the agency uses the natural and social sciences in the environmental design arts in planning and decision-making;
2. It assists in the evaluation of reasonable alternatives and the development of conditions, stipulations or modifications to be made a part of the proposed action;
3. It determines the need to prepare an EIS through an initial evaluation and determination of the significance of impacts associated with a proposed action;
4. It ensures the fullest appropriate opportunity for public review and comment on proposed actions, including alternatives and planned mitigation, where the residual impacts do not warrant an EIS; and
5. It examines and documents the effects of a proposed action on the quality of the human environment, and provides the basis for public review and comment.

2. Bureau of Land Management

The Bureau of Land Management is responsible for preventing unnecessary or undue degradation of federal lands under regulatory provisions in 43 CFR 3809. Federal regulations 43 CFR 3809.3-1 provide for a joint federal-state regulatory program. Such a program was initiated on April 30, 1984, by a Memorandum of Understanding between the BLM and DSL. Per the MOU, both agencies have participated in the review of this amendment.

3. Other state agencies

a. State Historic Preservation Office

The State Historic Preservation Office has the responsibility of cooperating with and advising DSL and the BLM when potentially valuable historical, archeological, or other cultural resources are located within a project area (Montana Antiquities Act MCA 22-3-401 through 22-3-442 and the National Historical Preservation Act PL 89-665 as amended and reauthorized E.O. 11593). Advice given may include comments on an applicant's plan for impact mitigation of sites eligible for nomination to the National Register of Historic Places. The office also reviews the environmental document to ensure compliance with cultural resource regulations. During mine operation, DSL and BLM are responsible for monitoring compliance with cultural resource laws and monitoring plans.

b. Department of Health and Environmental Sciences

i. Air Quality Bureau

The Air Quality Bureau of DHES administers the Clean Air Act of Montana (Title 75, Chapter 2 MCA). Any proposed project with potential to emit more than 25 tons per year of any pollutant must obtain an air quality permit prior to construction. The applicant must apply Best Available Control Technology to each emission source. The applicant must also demonstrate that the project would not violate Montana or Federal Ambient Air Quality Standards.

ii. Water Quality Bureau

The Water Quality Bureau of DHES is responsible for administration of the Montana Water Quality Act (Title 75, Chapter 5 MCA) providing for the classification of surface water, establishing surface water quality standards, and instigating permit programs to control the discharge of pollutants into state waters. A Montana Pollutant Discharge Elimination System permit must be obtained before any discharge to surface water may occur. This permit contains water quality limitations and requires self monitoring of effluent by the permittee. Mining operations must also comply with Montana groundwater standards.

c. Department of Natural Resources and Conservation (DNRC)

DNRC administers two acts that are applicable to mining development. These are The Montana Major Facility Siting Act (Title 75, Chapter 2, MCA) and the Montana Water Use Act (Title 85, Chapter 2 MCA). Any electrical transmission line that exceeds 69 kV or 10 miles in length requires state approval. A water rights permit is required for any surface water diversion or groundwater withdrawal exceeding 100 gallons per minute.

d. Hard-Rock Mining Impact Board

The Hard-Rock Mining Impact Board, created by the passage of the Hard Rock Impact Act (Title 90, Chapter 6, Part 3, MCA) is attached to the Montana Department of Commerce for administrative purposes. A quasi-judicial board, it

is intended to act as a referee in hearing disputes between local government and large scale mineral developers over the impact mitigation plan. The impact mitigation plan identifies the increased public sector costs associated with the mineral development and commits to pay, according to a specified time schedule, all increased capital and net operating cost to local government resulting from development. With a projected workforce totalling 225 employees, Golden Sunlight's mine would have met the definition of a large scale mineral developer, however, it was permitted prior to the effective date of the act and was grandfathered from compliance.

CHAPTER II - PROPOSED PLAN OF OPERATIONS AND RECLAMATION PLAN

A. Background - General Permit History and Explanation of Operations

The original operating permit was issued in June 1974; of the 4113-acre permit boundary, 300 acres were bonded for reclamation performance of mining disturbances. The mining plan involved initial heap leaching of oxidized surface ores, and eventual open-pit and underground production and mill processing of unoxidized sulfides from the mineralized breccia pipe. Proposed reclamation of the project mining disturbances included revegetation of haul road berms; covering of pit benches with alluvial borrow material and revegetating; reduction of slopes on waste dumps, leach pads and mill tailings to fifteen percent, topsoil placement and revegetation. Impoundments were to be built with 100-year flood spillways. Water treatment of pit water and mill tailing effluent was anticipated and committed to.

Amendment No. 1 was issued in April 1981. The revised mining plan incorporated open-pit production, a cyanide vat leach metallurgical extraction process, and construction of a tailing impoundment. The completed project would produce twenty million tons of ore and impounded tailing, and approximately 90.0 million tons of waste rock. An additional 722 acres were estimated to be disturbed, bringing the area bonded for reclamation performance to 1022 acres. Proposed reclamation of the mining disturbances of Amendment No. 1 were revised to reflect changes in the mining plan. Waste rock dumps were to be constructed to contain contour benches, and reclaimed slopes would be reduced to less than 2.5h:1v prior to topsoil placement and revegetation. Haul road berms would be rounded and graded into topography; road surfaces would be ripped, water-barred, and revegetated. The mill site, utility corridors and support facilities were to be removed, and the disturbance areas recontoured and revegetated. The tailing impoundment dike faces would be recontoured and revegetated. The tailing surface was proposed to be topsoiled "to the extent possible"; mill tailing test plots were established to evaluate different revegetation techniques and determine the feasibility of reclaiming the tailing surface. To prevent tailing effluent from contaminating area groundwater, a bentonite slurry cut-off trench was incorporated into the impoundment design to provide an impermeable barrier and prevent tailing effluent solutions from seeping into and mixing with groundwater. Monitoring wells were placed downgradient of the impoundment; a seepage collection pond would be constructed between the slurry cut-off trench and the embankment toe to collect tailing effluent for pumpback and evaporation. Long-term and detailed analyses of foundation and embankment seepage were proposed to further define reclamation water treatment requirements, and diversion structures upstream of the reclaimed impoundment were to minimize precipitation recharge of the tailing and subsequent effluent seepage by limiting the drainage area above the impoundment.

An Environmental Impact Statement prepared by the DSL prior to issuance of Amendment No. 1 concluded that the potential threat of hazardous substances entering the surface and groundwater systems of the area was an unavoidable adverse impact.

Amendment No. 2 was issued in October 1981, to provide an access road, water and telephone line corridor. Six additional acres were permitted for disturbance and the total area bonded for reclamation performance was 1028 acres.

In February 1982, at the request of GSM, the DSL agreed to accept design changes that varied from the proposed and permitted tailing impoundment design of Amendment No. 1. The impoundment blanket drain system, which was intended to drain tailing effluent and control the phreatic surface, was replaced by a less extensive, but functionally similar finger drain system. The operational diversion system above the impoundment was eliminated in favor of maintaining sufficient impoundment freeboard to retain a 100-year precipitation event. Upon decommissioning, the diversion system would be constructed if determined necessary for the success of final reclamation.

Amendment No. 3 was issued in April 1983, to extend the north waste dumps. Seventy additional acres were estimated for disturbance, bringing the total project area bonded for reclamation performance to 1098 acres. No reclamation changes were proposed, and the project reclamation was permitted in accordance with the procedures defined in Amendment No. 1.

Amendment No. 4 was issued in March 1984, for the proposed south waste rock dump. The additional dumping area disturbance was estimated to be 120 acres, bringing the total project area bonded for reclamation performance to 1218 acres. Reclamation of the south dump area was proposed and permitted as benched, with reclaimed slopes reduced to less than 2h:1v.

Amendment No. 5 was issued in July 1984, to allow construction of pumpback wells and an additional tailings slurry pipeline from the mill to the impoundment. Elevated cyanide levels in downgradient monitoring wells had resulted from failure of the slurry cut-off trench to function as designed, and pumpback wells were required to minimize further contamination of the area groundwater. Additional disturbed area was estimated at 23.4 acres, and the total area bonded for reclamation performance was 1241 acres. Reclamation of the tailings slurry pipeline corridor was to be "in accordance with previous applications", with the addition that gully fill would be removed for restoration of natural drainages.

The operating permit was revised in October 1985, for construction of a wing dike extension in the north portion of the tailing impoundment. No changes in the reclamation plan or area bonded for reclamation performance resulted from this revision.

The operating permit was revised in August 1987, to allow for a buffer zone west of the pit and for continued expansion of the north dumps. An additional 130 acres were estimated to be disturbed, and the total area bonded for reclamation performance was increased to 1371 acres. No reclamation changes were proposed or permitted with the revision.

The operating permit was revised in May 1988, to provide expansion room for the south dump. No changes in the reclamation of the project were proposed, and no adjustment of reclamation performance bond was made.

Amendment No. 6 was issued in December 1988, to allow additional area for expansion of the north, south and west waste rock dump complexes. The interim waste rock disposal area was needed to accommodate the 60.0 million tons of waste rock that remain to be produced from the mining plan that was proposed and permitted with Amendment No. 1 (April 1981). The area estimated for disturbance by the interim waste disposal expansion is 379 acres, bringing the total area bonded for reclamation performance to 1750 acres. Reclamation proposals for the waste rock dumps and associated project roads were revised with the amendment. Dump slopes are to be built at the angle of repose and reduced to 2h:1v for reclamation. Dump tops are to be ripped and graded, and dump tops and slopes would be topsoiled and revegetated. Road berms and some fill material would be placed against the cut slope to control drainage, and road surfaces would be ripped and water-barred prior to revegetation.

In addition to the reclamation procedures proposed by GSM, a condition of amendment approval stipulated that a detailed evaluation of the acid-producing potential and toxicity of pit wall rock, waste rock, and pit water would be conducted to evaluate the need for additional reclamation requirements.

B. Present Operating and Reclamation Plan

1. Operating Plan

The present operating and reclamation plan has evolved from the original operating permit No. 00065 and six amendments. The project is permitted to operate through mining Stage III, which would result in the deposition of 20.0 million tons of mill tailings and 90.0 million tons of waste rock.

Overburden removal and ore production are accomplished by conventional open pit mining techniques. Ore and waste material are drilled and blasted, loaded onto haul trucks, and transported to the mill and waste rock dumps. In plan section, the present pit edge encompasses approximately 100 acres. At the completion of Stage III mining, the pit is anticipated to have a surface expression of 140 acres, be 600 feet deep at the center, and have a 1600-foot highwall to the west.

Waste rock is extracted from pit benches and hauled to corresponding dump elevations at waste rock dump complexes to the north, south and west of the pit. At present, approximately 30.0 million tons, or one-third of the eventual waste production from Stage III mining, is deposited in the dumps. Waste dumps are constructed by end-dumping material from haul trucks. Dump tops and edges are dressed with dozers to create relatively smooth, level surfaces with safety berms at dumping points. Dump slopes are at the natural angle of repose for the material, about 36 degrees from the horizontal. By 1993, when Stage III mining is scheduled to be nearing completion, the waste dumps would cover approximately 320 acres, with vertical heights of 400 to 600 feet, and slope lengths commonly 1000 feet long. The dumps would ring the southern tip of the Bull Mountains, and bury drainages and natural landforms below the 6400-foot elevation on the west, the 6000-foot elevation on the south and the 5600-foot elevation on the east.

Ore is trucked from the pit to the mill where it is crushed to 64 percent minus 100 mesh and vat leached with sodium cyanide solution to extract gold. Mill head feed ranges from 5000 - 6700 tons of ore per day at 0.05 troy ounces of gold per ton. Mill tail feed is slurried to the impoundment at about 50 percent solids by weight.

The tailing impoundment is situated in a small drainage; the impoundment embankment is horse-shoe shaped, with the largest section of the dam in the drainage bottom and smaller wing dikes connecting to ridges to the east and west of the drainage. Ultimately, the impoundment would cover 198 acres to a depth of up to 135 feet. The embankment is constructed by the centerline method. Slurried mill tailings are cycloned on the embankment crest. Cyclone underflow, or sand-sized particles, are discharged directly on the dam crest, continually raising the embankment above the starter dam, and extending the downstream toe. Cyclone overflow consists of the finer fraction of mill tailing, and these slimes are spigoted into the impoundment. Depositional characteristics of the slimes result in a particle size distribution from coarse to fine from the embankment crest to the upstream end of the impoundment. A gradient is also created that causes slurry solution to pond at the back (upstream end) of the impoundment. The ponded slurry solution is pumped from a floating barge to the mill for recirculation.

The impoundment facility was designed to be a closed circuit system with zero ground water or surface water discharge. The impoundment has an underdrain system which allows water to seep beneath the dam where it is collected, in a lined pond, and pumped back to the impoundment. The underdrain was originally designed to be a layered gravel blanket drain placed beneath the dam and extending under the cycloned sands. Two finger drains extend around the impoundment perimeter to insure that no water seeps laterally through the perimeter ridges. The blanket drain was replaced in the final design with a series of finger drains beneath the dam (J. Smolik, written communication February 3, 1982). These drains are constructed of coarse gravel 2 feet thick and 8 feet wide (SHB Job No. E81-41, 1982, Vol. II, p. 5). Approximately 40.0 gpm discharges from the drain system while another 300 gpm reaches the pump back wells above the slurry cutoff wall through the alluvium (SHB Job No. E88-1 1988, Vol. II, p. 4). This water is probably both natural ground water and process water which has seeped through the floor of the impoundment and into the alluvium. The finger drains are incased in a Typar filter fabric to ensure free drainage during operation. This fabric is expected to deteriorate sometime after abandonment and the drains would function at a reduced capacity (SHB Job No. E80-89, 1981, p.4).

A 540-foot long, 2.5- to 4-foot wide bentonite slurry cutoff trench was located across the drainage below the lined drain water reclaim pond. This trench, extending to bedrock or impervious clay formations at a maximum depth of 58.8 feet, was constructed to ensure that no leachate escaped from beyond the impoundment area.

Solution required for operation of the mill is recirculated from the tailings impoundment pond. Water that is lost to evaporation or held within the impoundment tailings is supplied by pumping makeup water from the Jefferson Slough at a rate of 446 gpm.

Five groundwater monitoring wells were originally proposed and constructed. These wells were to be monitored quarterly to ensure that the impoundment facility was functioning properly (SHB Job No. E81-41, 1982, Vol. II, pp. 27-32). Presently there are 22 monitoring wells peripheral to the impoundment and 14 pumpback wells. Seven wells above the slurry cutoff trench pump an estimated 300 gpm from a channel aquifer at a depth of between 50 and 70 feet. The pumpback wells below the cutoff wall pump a minimal amount of water (approximately 15 gpm) from the same aquifer to ensure that no groundwater contamination leaves the permit boundary (John Arrigo and Darrel Sharf, personal communication, 1989).

2. Reclamation Plan

The present tailings impoundment would be filled to capacity by 1992, at which time surface reclamation would begin. The current reclamation plan states the reclamation objectives as "... prevent contamination of water and soil through erosion of tailing by wind and water, and to accelerate the reestablishment of a self-sustaining ecosystem" (Amendment No. 001, 1980, p. 1). To meet these objectives, the impoundment dike faces would be contoured and revegetated, the tailings would be covered with 3 to 6 inches of topsoil to the extent possible. If needed, permanent diversion would be built around the impoundment. Additional diversions, as needed, could be built during final reclamation to further reduce surface flow on to the impoundment and recharge of the tailings. A spring above the impoundment would also be diverted. These diversions, if installed, would reduce the watershed feeding the tailings pond from 1,043 acres to 138 acres. According to the company, this would eliminate the possibility of water discharge from under the impoundment even during a 100-year storm event. Diversions would be riprapped to minimize erosion. Upon final reclamation, the tailings system would be isolated from both surface and groundwater flows. The surface would be graded and gently sloped to eliminate any ponding on the surface (Amendment No. 001, 1980, p. 12; SHB Job No. E80-89, 1981, p. 11-14; SHB Job No. E81-41, 1982, Vol. I, p. 15). Diversions would not be necessary if reclamation of the tails and nondegradation of water can be achieved without them.

A permanent collection and evaporation pond is proposed at the base of the impoundment below the underdrain system. Additionally, Golden Sunlight would complete a more definitive estimate of post-operational seepage from the underdrain. This study would be completed upon final design of the impoundment (SHB Job No. E80-89, 1981. p. 11).

The specific seed mixtures and revegetation techniques were not defined in the 1980 plan, instead it was proposed that test plots be established within two years to evaluate a number of reclamation procedures. These procedures were to include different seed mixtures, fertilizer applications, mulching procedures, and topsoil application methods. The results of this program would be evaluated on an annual basis to produce the most acceptable method of reclaiming the tailings pond (Amendment No. 001, 1980, p. 12).

Twelve 30-foot by 80-foot subplots were constructed of whole mill tailings in the spring of 1984. All the plots were treated with 600 pounds of fertili-

zer per acre rototilled into the top 6 inches of tailings. Four reclamation strategies were attempted: 1) 4 inches of topsoil; 2) bare tailings with the addition of 5 tons per acre of calcium (Ca(OH)) plus 350 cubic yards per acre of woodchips; 3) bare tailings with 5 tons of calcium plus 15 tons of hay per acre; and 4) bare tailings alone.

The current reclamation plan for the mine dumps, which was revised in 1989 with Amendment No. 006, is as follows: All dumps would be constructed with slopes at the angle of repose (1.5h:1v). At completion, dump slopes would be reduced to 2h:1v. Runoff would be diverted off the top of the dumps until final reclamation is complete. Compacted areas on dump tops would be ripped prior to soil placement. Topsoil would be placed on dump slopes. Replaced quantities of soil material would reflect rock sizes and interstitial spaces on the dozed slopes. Volumes may be increased where uneven settling in larger voids could occur. Before seeding or planting trees, a minimum of six inches of soil material would be redistributed depending on the soil volumes which are salvaged. Approximately 75 percent of 2h:1v slopes would be covered with topsoil.

Preference for topsoil replacement and revegetation efforts would be given to those slopes which would be most visible from Montana Highway 69, Interstate 90, and the community of Whitehall.

Replacement of available topsoil on the dump slopes would require construction of access roads. Access road widths would be 14 feet without berms, or 20 feet with berms. Grades are anticipated to be 8 to 15 percent. Soil material would be hauled and dumped near the road crest edges, then dozers would spread the material downslope. Soil distribution would begin on the lower slopes and progress upward. Access roads in the dump faces would be left intact and utilized for broadcast seeding of the prepared seedbed. Small low areas, suitable for tree planting, would have greater depths of soil material placed on them. Most waste dump slopes would be seeded by broadcast seeding. Dump tops and slopes less than 3h:1v, which are free of rocks, would be drill seeded. Wood fiber mulch, crimped straw, and fertilizer would be applied to reduce erosion and promote plant growth. The proposed seed mixture contains both grasses and forbs and is composed predominantly of native species.

Weathered and oxidized material segregated from fresh waste rock would be used to supplement topsoil replacement, either as subsoil or alone to increase the percentage of cover. This mixture may be used to resoil the tops of dumps. First priority for placement of soil or oxidized material would be those areas which would be unable to support vegetation without it. Placement depth would reflect field conditions necessary to support vegetation. Dump tops would be planted with Douglas fir, Rocky Mountain juniper, and big sagebrush at various densities of seedlings per acre depending on species. Dump slopes would be planted with Douglas fir and Rocky Mountain juniper, as well as other shrubs such as bitterbrush, and rubber rabbitbrush.

Cut slopes for roads within the mine complex would be less than 1.5h:1v in unconsolidated materials and close to vertical in bedrock. Fill slopes would be constructed at the angle of repose. At reclamation, berms and some of the downslope material would be shaped back towards the cut faces with backhoes and

dozers. Outside crests would be rounded and shaped. Flat sections would be ripped and waterbarred. Mulch would be applied and approved seed mixtures with both grassland/forb mixtures and tree/shrub species would be planted (Amendment No. 006, 1988, pp. 48-49).

The following stipulations were attached to Amendment No. 006 and made a part of the operating permit:

1. Golden Sunlight Mines, Inc. would conduct a detailed evaluation of the acid-producing potential and toxicity of the pit, waste rock, and pit water. Sufficient number of samples would be collected to characterize the pit, waste rock, and pit water. Within 60 days of approval of this amendment, Golden Sunlight Mines, Inc., shall submit a plan for evaluating the acid-generating potential and toxicity of the pit, waste rock and pit water.

2. Golden Sunlight Mines, Inc. would monitor the existing seep at the toe of the "north dump" and any new seeps which appear during operations.

The present pit reclamation procedure calls for a perimeter berm around the edges and possibly a fence for safety purposes (Amendment No. 001, 1981, p. 15).

The mill complex and utility corridor would be recontoured and seeded and the facilities dismantled upon completion of mining (Amendment No. 001, 1981, p. 13).

C. Proposed Plan of Operations and Reclamation Plan

1. Operating Plan

Golden Sunlight Mines, Inc., has submitted an application to amend their operating permit to expand the operation. Proposed Amendment No. 007 would expand mine production from Stage III to Stage V, and extend the life of the mine to approximately the year 2005. Mining through Stage V would produce a total of 300 million tons of waste and 50.0 million tons of ore.

Pit production would continue with conventional methods, with waste rock disposal and ore processing through existing facilities. Stage V development of the pit would create a surface expression of about 190 acres. The proposed pit would remove the ridge top and east flank of the mountain, and would result in a 2,000-foot highwall on the west. The east side of the pit would daylight at elevation 5,375 feet. The pit bottom would be at elevation 4,800 feet, which is 1,200 feet below the existing hillside, and 225 feet below the existing groundwater table elevation.

Existing waste rock dump complexes would be expanded to contain 300 million tons, and cover approximately 691 acres. Compared to the present waste rock dump volume and area (approximately 30.0 million tons covering 125 acres) the Stage V dumps would be 10 times the volume and cover about six times the disturbed surface area.

The proposal to expand the project through Stage V mining would not alter the milling and metallurgical extraction processes; but would require another tailing impoundment to contain the additional milling wastes. The project is currently permitted through Stage III, which would result in approximately 20.0 million tons of impounded tailing; expansion through Stage V would require an increase of 30.0 million tons and eventual impoundment of 50 million tons of project tailings.

The proposed tailing impoundment is designed with a capacity for 30.0 million tons, and would be located immediately to the east of the existing and permitted facility. The impoundment would ultimately cover 250 acres to a depth of up to 150 feet. The present impoundment is estimated to reach maximum capacity in January 1993, requiring completion of first phase construction of the proposed impoundment by October 1992.

Dam alignment was selected to abut the eastern wing dike of the existing facility, and minimize the drainage area above the proposed impoundment. Diversions to route upstream runoff around the impoundment are not proposed, although these diversions were recommended to connect with the reclamation diversion channels that were to be placed around the existing impoundment (SHB Job No. E87-13, 1988, p. 3).

As with the existing facility, centerline construction of the embankment is proposed. Initial stages of construction would be comprised of a toe dike, starter dam and wing dikes of homogenous, predominately granular fill, taken from borrow areas within the permit boundary or from the floor of the impoundment. Cycloned sands would continually raise the embankment crest and extend the downstream toe from the starter dam, and wing dike extensions would be constructed in stages. The proposed impoundment design requires that a minimum freeboard of 10-12 feet be maintained to allow for containment of a 6-hour PMP precipitation runoff, and room for placement of a reclamation cover.

A 60-mil HDPE synthetic liner placed over a prepared surface is being proposed for the additional impoundment. The synthetic liner would cover the impoundment basin, and extend beneath the embankment starter dam, toe dike, and effluent reclaim ponds. A 5-foot layer of cycloned sands is proposed to cover the synthetic liner in the area beneath the starter dam, final dam and toe dike for protection of the liner during construction, and to provide a blanket drain beneath the main embankment. Gravel finger drains encased in geotextile would be constructed throughout the impoundment basin, connected to and passed through the cycloned sand blanket drain, the embankment and toe dike to two tailing effluent reclaim ponds. The drain system and reclaim ponds are designed for a 400 gpm capacity. These ponds would be double-lined and incorporate a leak detection system.

The proposed groundwater monitoring system was designed to detect changes in groundwater levels or chemistry that would indicate seepage from the impoundment. The array of pumpback wells to the east side of the existing impoundment are to be replaced by wells through the existing impoundment's east wing dike. The monitoring program would use five existing wells and four new wells. The new wells include one upgradient and three downgradient of the pro-

posed impoundment. The groundwater monitoring program is proposed to include water table elevation measurements and water quality analyses.

2. Reclamation Plan

a. Waste Dumps

The waste dumps would be constructed and reclaimed in the same manner as previously described for the 1989 expansion, DSL Preliminary Environmental Review dated December 9, 1988, and as proposed in Amendment No. 007.

b. Impoundment Reclamation

The reclamation objectives for the proposed tailings impoundment are similar to the original facility "... to establish a self-sustaining ecosystem which would minimize contamination of water and erosion of tailings and soils."

These objectives would be met by temporary stabilization techniques, reclamation during mining, final reclamation, and monitoring with possible remedial action.

i. Temporary Stabilization

Prior to construction, topsoil would be stripped from all disturbances and random borrow locations. Stripping would be accomplished using scrapers or dozers and trucks. Removal depths would vary according to soil inventory reports, however, enough topsoil would be available to place a minimum of 6 to 12 inches over the final tailings impoundment. Topsoil stockpiles and random borrow areas which would remain for longer than two years would be contoured and drill seeded at a rate of 16.5 lbs per acre or broadcast seeded at a rate of 33 lbs. per acre with an approved seed mix specified in the amendment. Areas and stockpiles which are short-lived, less than 2 years, would be seeded with a cover crop such as barley.

ii. Concurrent Reclamation

The embankment top and outer surface would be reclaimed after the dam has reached its ultimate height. One-half to one foot of topsoil would be placed over these areas. The flanks at 2 1/2h:1v would not be reduced prior to topsoil placement and broadcast seeding. A tackifier of wood fiber mulch, at 2000 lbs/acre, would be hydro-sprayed over the seeded area to reduce erosion and promote seedling establishment. The dam crest would be drill seeded. The specific seed mix and soil amendment techniques would be determined after test plot evaluation.

Borrow areas would be topsoiled, if necessary, and seeded. Slopes less than 3.5h:1v would be drill seeded while steeper slopes would be broadcast seeded and mulched. All areas would be fertilized after the first growing season or before the spring rains.

During operation, wind erosion would be mitigated by compacting the surface of the downstream earthen fill and with dust suppressant chemicals on

the sand surfaces of the impoundment. Most of the fines in the main body of the impoundment would remain wet and, therefore, not susceptible to wind erosion.

iii. Final Closure

Upon final closure of the impoundment facility, the reclamation goals would be to:

1. Flatten the tailings surface by adjusting the final spigot points.

This procedure would fill the low areas at the upstream end of the facility, bringing the final grade to less than 0.6 percent. This would also place coarser sand material, which is considered a better plant medium, over the finer slime fraction of the tails.

The top of the dam and wing dikes would be rounded off. The impoundment would still have enough freeboard to contain the 6-hour PMP storm event.

2. Dewater the tailings as quickly as possible, especially at the surface.

Surface water is expected to be only several inches deep. The plan is to dissipate this water by evaporation and/or decanting it to a sprinkling system on the tailings surface. The water remaining in the tails would drain through the finger drain system to the lined collection ponds below the facility where it would than be pumped to the sprinkler system to hasten evaporation.

The sandier portions of the impoundment, nearer the downstream end and closest to the dam, are expected to be dried within the first year or two of closure. Reclamation efforts would start there.

3. Deposit an effective 2-foot minimum thickness of random mine rock cover (rock cap) over the surface of the tailings that would function as a textural break to prevent the upward migration of moisture in the tailings, containing metals, salts, and acid, and to eliminate wind erosion.

This procedure, starting from the drier areas and working inward, is expected to begin within the first year of reclamation and to take up to five years to complete. Care would be taken so that the rock would not be shoved downward into the wet tailings and the effectiveness of the rock cap lost.

Riprap of very coarse mine rock would be placed at the mouth of the intermittent drainages above the tailings to prevent headward erosion. These drainages are expected to discharge water into the impoundment only during the 100 year storm event. The area drained by these gullies is less than one-half the area of the impoundment itself.

4. Spread soil over the rock cap material and compartmentalize the reclaimed surface.

One-half to one foot of top soil or alluvial borrow would be placed over the mine rock utilizing scrapers or end-dump trucks and graders. Berms would be created periodically to segment or terrace the surface to prevent precipitation from collecting in isolated low spots. This procedure is expected to enhance plant uptake of water and inhibit recharge of the tails by ponding the water more evenly over the surface.

5. Establish a permanent self-sustaining vegetative community.

A final seed mixture has not yet been determined. Information developed from the test plots and from reclamation experience gained from impoundment I would be used to finalize the reclamation effort. Test plot research completed on impoundment 1, however, does not replicate reclamation plans proposed by GSM. For example, GSM initially treated all plots with 42 lbs/acre elemental sulfur and a mixture of fertilizers which are not proposed in GSM's reclamation plan, but alter soil chemistry and affect pH. Additionally, the four feet of whole tailings used in the test plots may not necessarily replicate final conditions within the impoundment. Although GSM would use whole tailings to fill low areas at reclamation, the proposed depths are unspecified in the reclamation plan and are unknown.

Western Reclamation, Inc.'s final report concludes that the surface twelve inches or more of tailings should be neutralized with adequate quantities of lime before soil is applied and that further test plots should be studied.

6. Reclamation of underdrain reclaim ponds located below the dam.

GSM anticipates that very little water would discharge from the underdrain system after the first couple of years. This water would be monitored and pumped from the reclaim ponds to the sprinkler system on the impoundment surface. If acceptable water quality standards are reached, a MPDES discharge permit would be obtained and the water allowed to overflow the ponds. If the quality doesn't improve, the water would be treated and remedial action taken. If the flow decreases or stops, the liner would be removed and, if necessary, one foot of topsoil would be placed over the side slopes and bottom. The area would then be broadcast seeded and mulched.

iv. Monitoring and Remedial Action

Monitoring during final reclamation would involve qualitative visual evaluation of plant communities as well as quantitative counts of species and productivity.

Surface and groundwater monitoring would continue at the same level that monitoring was taking place at the time of closure. This level of monitoring is proposed for one year after final shut down. If no problems occur, the level of monitoring would be reduced after one year by 66 percent, after three year by 84 percent, and eventually discontinued or monitored once a year after year six. If problems are noted, monitoring frequency and intensity could be modified. Presently, it is proposed that 11 groundwater monitoring wells would be monitored monthly for: water level, pH, specific conductance, temperature, alkalinity, total dissolved solids, cyanide concentration, and nitrate/nitrite

levels. Quarterly measurements would include: potassium, sodium, calcium, magnesium, chloride, fluoride, sulfate, ammonium, bicarbonate, and carbonate. Yearly measurements would include all of the above plus, common heavy metals as well as sulfide and thiocyanate.

Remedial action would focus on excessive wind blown dust, poor revegetation success and water contamination. These actions may involve additional surface preparation for areas that are not revegetating, including: mulching, soil stabilization, rock surfacing, additional plantings, and irrigation. All water discharge must meet state and federal regulations. If degradation occurs, water would be collected and treated or evaporated on site. Treatments may include the addition of hydrogen peroxide or hypochlorite and reverse osmosis techniques with pH modification and sludge removal prior to irrigation, evaporation or discharge.

When reclamation and monitoring efforts are deemed complete, the pumpback wells and monitoring wells would be abandoned in such a manner as to prevent crossflow between any multiple aquifers. This would include the removal of all surface facilities and underground pumps, pipes, and filter packs. The holes would then be filled with an expanding sealant from bottom to top.

3. Pit Reclamation

The pit would eventually deepen to the 4800-foot level, leaving a 2000-foot highwall on the western edge. The northern and southern sides would slope to a 575-foot highwall on the eastern edge of the pit. The pit would be roughly circular in shape, approximately 2000 feet in diameter, covering 190 acres. The perimeter would be bermed and possibly fenced for safety (Amendment No. 001, 1980, p. 13).

Water would be encountered at the 5025-foot level. This water would be pumped to the mill as makeup water during active mining. Upon abandonment, water would be allowed to collect in the pit bottom, creating a "lake" approximately 52.0 acres in size and 225 feet deep. The east high wall would be 325 feet above the water level. No surface discharge is expected. There are no adits below the lake surface that could experience increased discharge.

The lake water is expected to be of poor quality with pH levels close to 2.4 and elevated metal content.

4. Utility Corridor Reclamation

Approximately 5,000 feet of twelve-inch pipe would be laid in a new fifteen-foot wide prepared bed to slurry tailings to the new impoundment. This disturbed area, as well as other utility corridors including freshwater and electrical power, would be reclaimed by removal of surface facilities and regrading, contouring, and seeding where practical.

CHAPTER III - EXISTING ENVIRONMENT

A. GEOLOGY

The Golden Sunlight gold-silver deposit is located at the southern end of the Bull Mountains, in the Whitehall mining district, Jefferson County, Montana. The project area is located within an upthrown fault block that exposes Belt Supergroup rocks, which are overlain by Paleozoic rocks and Mesozoic volcanics, which are intruded by Tertiary igneous rocks.

Two major northerly trending high angle normal faults, the St. Paul fault to the west and Golden Sunlight fault to the east, form a horst within which the project area is located. Minor E-W normal and reverse faults transect the horst and cut the Golden Sunlight and St. Paul faults. Two sets of fractures are evident in the area. One set parallels the Golden Sunlight fault and the other trends NE-SW. The siliceous breccia pipe, approximately 700 feet in diameter, occurs within the horst and is the primary host for gold mineralization (Porter and Ripley, 1985, p. 1692).

The oldest exposed rocks in the project area include the LaHood, Newland and Greyson Formations, of the Belt Supergroup. The LaHood Formation is a coarse arkosic sandstone and argillic shale. The Newland Formation contains calcareous shales, black limestones and thin bedded calcareous, sometimes weakly silicified, siltstones. The Greyson Formation is a silty shale and argillite. The Newland and LaHood Formations are ore hosts and become silicified toward the breccia pipe (Porter and Ripley, 1985, p. 1692).

Paleozoic rocks include the Flathead Quartzite, Wolsey, and Meagher Formations. The Flathead Quartzite is a fine grain sandstone or orthoquartzite. The Wolsey Formation is a sandy shale containing interbedded sandstones and thin bedded limestones. The Meagher Formation is a thin bedded, finely crystalline limestone, containing shaly interbeds.

The youngest rocks belong to the Bozeman Group which in this area are broken into a basal breccia, conglomerates, sandstones, shales, calcareous siltstones and an upper series of fined grained arkosic rocks (Porter and Ripley, 1985, p. 1962). The coarse-grained lower units belong to the Climbing Arrow Formation and the upper units are in the Dunbar Formation. The proposed tailings impoundment would be constructed on the Bozeman Group rocks.

Igneous rocks in the immediate vicinity of the Golden Sunlight mine fall into three main categories: Elkhorn volcanics, latite porphyry and lamprohyre intrusives. The Elkhorn volcanics consist of andesite, andesite porphyry flows, tuffs and agglomerates. The latite porphyry is the most abundant igneous rock present in the area. It is tan to cream colored, and is comprised of 50 percent feldspar-biotite matrix and 50 percent plagioclase and orthoclase phenocrysts (Porter and Ripley, 1985, p. 1692), which are often altered to clay minerals. The ore host breccia crosscuts the latite porphyry. The lamprophyre intrusives are andestic to basaltic dikes and sills. They consist of a dark biotite-augite-plagioclase groundmass with biotite and augite phenocrysts. The lamprophyres are altered but lack sulfide mineralization (Porter and Ripley, 1985, p. 1692).

The mine is centered on a siliceous breccia pipe which contains disseminated mineralization that extends more than 100 feet into the wallrock in silicified fractures. The pipe is an irregular oval, approximately 700 feet in diameter, which plunges 35 degrees to the west. Individual breccia fragments may be greater than 30 feet in size and consist of all rock types except for the lamprophyres. Alteration consists of pyritization, silicification and decarbonization with an alteration mineral assemblage containing silica, pyrite, barite, sericite, chalcopyrite, galena, sphalerite, and molybdenite. Gold occurs as disseminated particles associated with the pyrite in the breccia matrix, auriferous pyrite, and minor telluride minerals. Superimposed across the breccia pipe and into the surrounding wall rock are NE trending gold-quartz veins that may contain pyrite, galena, sphalerite, and barite (Porter and Ripley, 1985, p. 1692).

Waste rock contains 5-10 percent sulfides of which 99 percent is pyrite with minor amounts of chalcocite, chalcopyrite, bornite, galena, sphalerite and barite. A single "highwall composite" was determined to be a potential acid producer (B.C. Research, 1988, written communication to Golden Sunlight, p. 1). The exact samples and locations used to fashion the "highwall composite" is unknown. Consequently the sample result may not be representative of the waste rock GSM proposes to place on the existing dumps. The test conducted to determine acid producing potential was performed on finely ground material, -400 mesh, and does not portray the actual waste rock dump material, which is much coarser. Toxicity of the waste rock is unknown. Based on the minerals present, in the waste rock, it may contain high levels of Al, Ba, Cd, Cu, Fe, Mn, Ni, Pb, Se, and Zn, which can be considered an incomplete list.

A single composite leached pulp sample was determined to be a potential acid producer (B. C. Research, 1988, written communication to Golden Sunlight, p. 1). This has partially been confirmed by overburden analyses of a tailings rehabilitation report by Western Reclamation, Inc., and GSM (1987, Attachment E, p. 7), which reveals three samples having acid/base potential of -59 to -72. These samples would need 59 to 72 tons of $CaCO_3$ per 1000 tons of tailings material to neutralize them.

Analyses of tailings material and leachate are found in Table 2. The pH of the tailings vary between 6.66 to 8.50 with a cyanide concentration of 51.2 mg/l. Western Reclamation, Inc., and GSM (1987, Attachment E, p.7) report the textural composition of 12 tailings sample to contain 54.5 percent sand, 24.3 percent silt and 21.2 percent clay.

Table 2. Tailings and Leachate Analyses

	Tailings (ppm)		Leachate (mg/l)	
Element	(1) n=1	(2) n=12	(1) n=1	(3) n=12
Al	34.0	----	.712	
Ba	19.9	----	.074	
Ca	20.0		89.0	
Cd	----	.010	.003	
Cu	----	14.2	65.3	
Fe	530	12.7	.311	
Pb	.580	.180	.045	
Mg	14.8		.215	
Mn	2.75	.300	.065	
Na	50.0		1,168	
Ni	9.50	.660	.304	
Se	1.10	.010	----	
Zn	1.75	.350	1.95	

(1) B. C. Research, 1980, (2) Western Reclamation, Inc., and GSM, 1987, (3) Multitech, 1989, written communication.

The existing pit wall rock is composed primarily of Tertiary latite porphyry, Greyson and Newland Formations of the Belt Supergroup. Though considerable deformation has occurred the conventional benched configuration of the pit and silicified wall rock result in operational stability.

Waste rock material is non-cohesive, angular, and relatively large with few fines. Dump complexes to the south and west are competently founded on arkosic quartzites and argillites of the Lahood Formation. The north dump complex is being constructed on Greyson and Newland Formation alluvium that overlies Bozeman Formation sediments. Most of the dumps in the north complex are stable, but foundation failure and creep has occurred where alluvium has been covered and mixed with substantial Quaternary landslide deposit known locally as the Midas Slump (DSL PER, Amendment No. 6, 1988, p. 10-11). A small seep issues from this area and is believed to originate within the landslide material.

The existing tailings impoundment is constructed on Quaternary alluvium and Bozeman Group rocks. The centerline method of embankment construction, and minimization of the phreatic surface contribute to the operational stability of the impoundment. Phreatic surfaces and pore pressures within the impoundment are controlled by the finger drains and seepage through the clay liner. A natural alluvial channel 50 feet beneath the impoundment, in the Climbing Arrow Formation, and pumpback wells to the south and east of the impoundment prevent foundation saturation. The minimum static factor of safety has been analyzed at 1.58. The minimum psuedostatic factor of safety, assuming a design peak particle acceleration of twenty percent of gravity, has been analyzed at 0.91.

B. Soils

1. Soil Developmental Setting

a. Parent Material/Geology

Bedrock geology maps of the area indicate the presence of volcanic and sedimentary rocks with a wide variety of ages. Precambrian Greyson and LaHood Formations are the dominant bedrock type in the expansion area west of the mountains. Tertiary age volcanic intrusive rocks occur in the bedrock of the proposed dump sites on both sides of the Bull Mountains. Soft sedimentary rocks of Tertiary age are the bedrock in most of the proposed tailings impoundment area and lower slopes of the north waste rock dump expansion area. Overlying the Tertiary valley fill are Quaternary alluvial and colluvial deposits that covered the valley fill before drainages were dissected. Benches that formed after drainages cut through the area were covered with Pleistocene age, wind-blown, loess deposits. The most recent surficial deposits in the area include colluvial and alluvial fans on terraces near toe slopes, and alluvium along drainageways.

b. Other Soil Forming Influences

Soils are relatively young, having formed in the geologic materials over the last 10,000 years since the retreat of the glaciers.

Soils have developed slowly in the semiarid continental climate. Precipitation varies from ten inches in the lowest elevations, in the rain shadow on the east side of the mountains, up to twenty inches in the upper elevations on the west side of the mountains. Effective precipitation is modified by slope, aspect, snow drifting and effects of runon and runoff moisture when rainfall intensity exceeds soil infiltration rates.

Vegetation is dominated by the grasses typical of the mixed grass prairies and shrub steppes, particularly in the lower elevations on the east side. In the foothills closer to the mountains, vegetation is dominated by the grasses and shrubs characteristic of the foothill mountain grasslands, interspersed with varying amounts of coniferous trees including rocky mountain juniper, limber pine, and douglas fir.

Slopes vary from zero to over 75 percent on all aspects. Over one-half of the waste rock dump expansion area west of the mountains has slopes greater than 45 percent. Elevations in the proposed permit boundary range from 4400-6600 feet.

2. Existing Soils

Soils of the proposed expansion areas were identified, characterized and mapped into nineteen soil type/association units (Table 3). The major soils were described in each of the three disturbance areas. Data presented has been interpreted from the soil survey data provided by GSM and the Jefferson County

Table 3 - Summary of the Major Properties of the Soils in the Expansion Areas at Golden Sunlight Mines

Table 3. Summary of the Major Properties of the Soils in the Expansion Areas at Golden Sunlight Mines

Units	Soil Types	Slope %	Depth/ Drainage	Physiographic Position
1BC, 1CD (1BCST)	Aridic Argiboroll and Borollic Haplargid loamy skeletal mixed (stoney phase)	2-15	deep, well-drained	flat terraces fans, rolling fans
2BC	Ustic Torriorthent coarse silty - coarse loamy mixed, frigid	2-8	deep, well-drained	terraces, benches
3BC, 3CD	Borollic/Ustollic Haplargids coarse to fine loamy mixed, frigid	2-15	deep, well-drained	toe slopes/ narrow swales and drainages
4BC, 4CD	Borollic Calciorthids loamy skeletal mixed	2-15	deep, well-drained	benches
5CD (5FG on steep slopes)	Ustic Torriorthent fine to coarse loamy mixed, frigid	4-60	deep, well-drained	ridges, upper slopes to mid-slope fans and swales
6DE	Ustic Torriorthent/Cumulic Udic Haploboroll fine loamy mixed	8-30	deep, well-drained	mid toeslopes
	Borollic Calciorthids fine loamy mixed	8-30	deep, well-drained	mid toeslopes
7BC, 8FG 8GF, 9EF 10G	Minor soils east of the mountains; Fluvents, Argids-Borolls; Orthents; streambanks and dissected uplands	2-75	shallow to moderately deep, well-drained	floodplains of ephemeral streams, channel banks sideslopes of dissected terraces and uplands, mountain slopes
11EF	Typic/Aridic Ustochrepts/ Udic Haploborolls loamy skeletal-to-coarse loamy mixed	15-45	deep, well-drained	toeslopes and fans
12F	Typic Ustochrepts	30-45	deep, well-drained	lower mountain slopes
12G	Aridic Ustochrepts and Argi/ Haploborlls; loamy skeletal mixed	45-75	shallow to moderately deep, well-drained	steep mountain sideslopes
13DE	Lithic Typic Ustochrepts/ lithic Haploborolls loamy skeletal mixed to fine loamy	8-30	shallow to moderately deep, well-drained	mountain ridges

			Relative Abundance in Expansion Area		
Parent Materials	Elevation	Vegetation	Tailings	North Dumps	West Dumps
colluvial sedimentary rocks	5000 - 5500 ft.	big sagebrush/ blue grama	--	Major	--
loess over colluvial and alluvial sediments	4600 - 5100 ft.	needle-and-thread/blue grama	Minor	Minor	--
alluvial and colluvial soft sandy Tertiary valley fill	4500 - 4800 ft.	big sagebrush western wheatgrass/blue grama	Major	--	--
alluvium from volcanic and sedimentary rocks	4700 - 5200 ft.	big sagebrush/ needle-and-thread	Minor	Minor	--
residual and colluvial soft sandy, Tertiary fill	4600 - 4800 ft.	blue grama/ needle-and-thread; big sagebrush	Major (Minor)	--	--
Loess and colluvium from sedimentary rocks over Tertiary valley fill	4500 - 5200 ft.	needle-and-thread/blue grama/western wheatgrass, big sagebrush	--	Major	--
Loess and colluvium from sedimentary rocks over Tertiary valley fill	4500 - 5200 ft.	needle-and-thread/blue grama/western wheatgrass, big sagebrush	--	Major	--
Alluvium, colluvium, residuum, eolium, Tertiary valley fill, volicanic and meta-sedimentary rocks	4500 - 6000 ft.	mixed shrub steppe, grasslands, and conifers	Minor	Minor	--
colluvium from meta-sediemntary rocks	5000 - 5500 ft.	big sagebrush/ bluebunch wheatgrass/idaho fescue	--	--	Major
colluvial metasedimentary rocks	5200 - 5800 ft.	bluebuch wheatgrass/idaho fescue	--	--	Major
colluvium and residuum from Greyson and Lahood argillites and quartzites	5000 - 6500 ft.	bluebunch wheat grass/idaho fescue/douglas fir/limber pine	--	--	Major
colluvium and residuum from Greyson and Lahood argillites and quartzites	5300 - 6500 ft.	douglas fir/ limber pine/ idaho fescue/bluebunch wheatgrass	--	--	Major

Table 4. Proposed Tailings Impoundment Area Soils

Unit	%	Major Soils	(-----Acres------) Total	Salvageable	(------Proposed------) Salvage Depths (inches) GSM	DSL	(------Total------) Salvage Volumes (BCY) GSM	DSL	Differences in Interpretations Of soil Salvage Criteria
3BC	55%	Borollic Haplargid coarse loamy mixed frigid	22	22	19	60	56,200	177,400	Textural Constraints GSM: Percent Sand, Clay DSL: No limits due to mixing Carbonates in lower profile used by GSM DSL: No limits, carbonates beneficial
	30%	Borollic/Ustollic Haplargid fine loamy mixed							
3CD	65%	Borollic Haplargid Coarse loamy mixed	68	68	18	60	164,500	548,500	Carbonates in lower profile used by GSM DSL: No limits, carbonates beneficial
	20%	Borollic Haplargid fine loamy mixed							
5CD	40%	Ustic Torriorthent fine loamy mixed	87	87	10	60	116,900	701,800	Textural Constraints GSM: clay loam DSL: no limits due to mixing
	60%	Ustic Torriorthent coarse loamy mixed, frigid							
		MINOR SOILS (6)	94	51	*	*	53,000	270,900	Same differences as above, plus coarse fragments: GSM: 35%; DSL 50%
		TOTALS	271	228			390,600	1,698,600	
		DEPTH OF SOIL AVAILABLE FOR REPLACEMENT ON 271 ACRES (VOLUME ÷ ACRES)					11 INCHES	46 INCHES	

* Salvage depth of soils varies from 0-60 inches

Table 5. North Waste Dump Expansion Area Soils

Unit	%	Major Soils	(-----Acres------) Total	Salvageable	(------Proposed------) Salvage Depths (inches) GSM	DSL	(------Total------) Salvage Volumes (BCY) GSM	DSL	Differences in Interpretations Of soil Salvage Criteria
1BC	60%	Aridic Argiboroll loamy skeletal mixed, frigid	78	78	9	54	94,200	565,500	Coarse Fragments GSM: 35%; DSL: 50%
	25%	Borollic Haplargid loamy skeletal mixed							
1CD	40%	Aridic Argiboroll loamy skeletal mixed	41	41	8	49	44,400	272,000	Coarse Fragments GSM: 35%; DSL: 50%
	50%	Borollic Haplargid loamy skeletal mixed							
5DE	40%	Ustic Torriorthent fine loamy mixed	47	47	7	60	44,000	377,500	Coarse Fragments GSM: 35%; DSL: 50% Textural Constraints GSM: Clay Percentage DSL: No limits due to mixing
	15%	Cumulic Udic Haploboroll fine lomy mixed							
		MINOR SOILS (5)	58	40	*	*	93,500	145,200	
		TOTALS	224	206			276,100	1,360,200	
		SOIL IN EXISTING STOCKPILES					160,000	160,000	
		TOTAL REPLACEMENT VOLUME					436,100	1,520,200	
		DEPTH OF SOIL AVAILABLE FOR REPLACEMENT ON 309 ACRES (VOLUME ÷ ACRES)					10 INCHES	36 INCHES	

* SALVAGE DEPTH OF 5 SOILS VARIES FROM 0 - 60 INCHES

USDA-SCS office in Whitehall, Montana. Emphasis has been placed on those soils that would constitute a significant portion of soil salvaged for use in reclamation.

a. Proposed Tailings Impoundment Area East of the Mountains

Nine soil mapping units were identified in the 271 acres of disturbance for the proposed tailings impoundment (Table 4). An abundance of soil exists in the area for salvage with three soil types (Units 3BC, 3CD, 5CD) representing over 65 percent of the total disturbance area and over 84 percent of the total soil volume available for salvage. Elevations range from 4600-4800 feet. The dominant vegetation is mixed grass prairie and big sagebrush-steppe.

The dominant soils are deep, well-drained, loamy, and on slopes from zero to 15 percent.

Possible limitations to use of the soils reviewed by GSM and DSL to calculate salvageable depths include: steepness; calcium carbonate, sodium (Na), and coarse fragment content in the lower profile; rough broken topography; sand and clay soil horizons; and the presence of rock outcrop. The soils were listed as having fair salvage volumes to 60 inches in the soil survey (MSE, 1988). GSM proposes to salvage 10 to 19 inches of these soils.

b. North Waste Rock Dump Expansion Area

Eight soil types in the proposed expansion area covering almost 224 acres would be disturbed by the ultimate north waste rock dump (Table 5). Three soil types (Units 1BC, 1CD, 6DE) represent 74 percent of the total disturbance area and 66 to 89 percent of the total salvageable volume. Elevation of the proposed expansion area ranges from 4900-6000 feet. The dominant vegetation is characterized by species typical of the foothill mountain grasslands. The setting is dominated by the proximity of the mountains.

The dominant soils are moderately deep to deep, well-drained, loamy soils on slopes from 2 to 30 percent.

Possible limitations to use of these soils used by GSM and DSL to calculate salvageable depths include: slope steepness, coarse fragment, calcium carbonates, sodium (Na), and sandy soil textures in the lower profiles, clay content in various horizons and the presence of rock outcrop. The soils were listed as having fair salvage value to 19 to 31 inches in the soil survey. GSM proposes to salvage 7 to 9 inches.

c. West and South Waste Rock Dump Expansion

GSM proposes to salvage soil on 228 out of a total of 487 acres (47 percent) to be disturbed on the west side of the mountains. Four soil types (11EF, 12F, 12G, 13DE) were identified (Table 6). Elevations range from 4900-6600 feet. The dominant vegetation is mountain foothill grassland with varying amounts of conifers, especially on north slopes.

Table 6. Soils in Waste Rock Dump Expansion Area South and West of the Mountains

Unit	%	Major Soils	(-----Acres------) Total	Salvageable	(------Proposed------) Salvage Depths (inches) GSM	DSL	(------Total------) Salvage Volumes (BCY) GSM	DSL	Differences in Interpretations Of soil Salvage Criteria
11EF	35%	Typic/Aridic Ustochrept loamy skeletal mixed	38	31	13	27	54,000	112,100	Coarse Fragments GSM: 35%; DSL: 50%
	25%	Typic Ustochrept coarse loamy mixed							
	30%	Udic Haploboroll loamy skeletal mixed							
12F	100%	Typic Ustochrept coarse loamy mixed	95	68	0	60	0	545,300	Coarse Fragments GSM: 35%, DSL: 50%
12G	35%	Aridic Ustochrept loamy skeletal mixed	284	70	6	20	56,400	188,200	Coarse Fragments GSM: 35%; DSL: 50%
	30%	Aridic Haploboroll loamy skeletal mixed							
	35%	Aridic Argiboroll loamy skeletal mixed frigid							
13DE	30%	Typic/Aridic Ustochrept loamy skeletal mixed frigid	70	59	7	7	55,900	55,900	
	35%	Lithic Haploboroll fine loamy mixed							
	35%	Lithic Ustochrept loamy skeletal mixed							
		TOTALS	487	228			166,300	901,500	
		EXISTING SOIL IN STOCKPILES					180,000	180,000	
		TOTAL REPLACEMENT VOLUME					346,300	1,081,500	
		DEPTH OF SOIL AVAILABLE FOR REPLACEMENT ON 416 ACRES (VOLUME ÷ ACRES)					6 INCHES	19 INCHES	

The four soil types are variable, being shallow to deep, well-drained loamy soils on slopes from 8 to 75 percent. Salvage depths vary from 6 to 60 inches, depending on slope steepness, rock content, and depth to bedrock. GSM proposes to salvage 7 to 13 inches on 228 acres. Major factors limiting salvage are slope steepness and coarse fragment content.

C. Hydrology

1. Surface Water

The area of the proposed waste rock dumps is drained by a number of small ephemeral channels. These channels coalesce to the east to form St. Paul Gulch, an ephemeral contributor to the Boulder River. Other channels drain to the south and are ephemeral contributors to the Jefferson Slough area. Major perennial surface water resources in the area are the Boulder River, which flows north to south approximately 1.3 miles to the east of the proposed permit boundary and the Jefferson River, which flows west to east approximately 1.4 miles to the south of the permit boundary.

The Jefferson River forms approximately 25 miles to the southwest from the Golden Sunlight area from the confluence of the Beaverhead and Ruby Rivers. From the amendment area, the Jefferson is joined by the Boulder River and goes on to combine with the Gallatin and Madison Rivers to form the Missouri River near the town of Three Forks, Montana. The Jefferson River currently is heavily used for irrigation both upstream in the Beaverhead River reaches and in the Jefferson River proper area. A USGS station on the Jefferson River at Three Forks approximately 25 miles downstream has been maintained since 1978. Records for this station indicate a drainage basin area of 9,532 square miles, an average flow of 2,421 cfs, a maximum recorded flow for the period of record of 15,900 cfs and a minimum recorded flow of 250 cfs. Water quality on the Jefferson indicates that it is an alkaline water of medium hardness, with calcium carbonate forming the dominant alkaline component (Montana Department of Fish, Wildlife and Parks, 1988).

In contrast, the Boulder River forms as the Little Boulder River combines with several other channels in the vicinity of Boulder Montana. From here, the Boulder flows in a southeast and then southerly direction, joining with the Jefferson River near the proposed amendment site. A USGS gaging station has been maintained on the Boulder River at Boulder (approximately 30 miles upstream of the proposed amendment) intermittently since 1924. These records indicate a drainage basin area of 380 square miles for the site, with an average flow of 120 cfs, a maximum recorded flow of 7,000 cfs and a minimum recorded flow of 0. Water quality in the Boulder River drainage is neutral to alkaline with variable metal concentrations, frequently as a result of previous mining activity in the area (Montana Department of Fish, Wildlife and Parks, 1988).

Currently permitted mining has impacted a number of the ephemeral drainages in the area. The deposition of waste rock in these areas has probably influenced the runoff/infiltration relationships for these areas, and has probably altered some local hydrologic parameters such as lag time and time of

concentration. However, these changes have not had a discernable impact on the hydrology of either the Boulder or the Jefferson River.

The area of the proposed tailings impoundment is drained by ephemeral channels that flow southward to the Jefferson Slough. These channels drain areas ranging from several to several hundred acres in size, and contain water only in response to snowmelt and precipitation events.

The proposed tailings impoundment will lie adjacent to the currently permitted impoundment. The current impoundment (called Impoundment I) is designed to contain all runoff from above. The removal of this runoff contribution area has likely influenced the "normal" hydrologic condition in the area. However, no discernable impacts to flow in the Jefferson River has resulted from this change.

2. Groundwater

Groundwater movement in the proposed amendment area occurs in several distinct aquifers. These can be generally classed as the bedrock system, a less inundated Tertiary system and an alluvial system.

Groundwater occurrences in the mine pit will be controlled by water movement in the PreCambrian LaHood, Newland, and Greyson formations of the Belt Supergroup. Water movement in these formations is in response to the development of secondary fracture permeabilities since the formations themselves are generally tight. This system is expected to have little sustained water production capability and hydraulic conductivities are highly variable depending on the number and nature of the fracture intercepted. Groundwater quality of this water may be poor due to the presence of sulphide minerals in the host rock and the production of low pH and metal mobility problems. PH values for the Ohio adit have been reported to be in the 2-3 range, with estimated high amounts of metals also present.

The areas of the waste rock dumps and some of the tailings impoundment are underlain by the Climbing Arrow and Dunbar Formations of the Tertiary Bozeman Group. These formations are highly variable in their transmissivities and conductivities, and locally may form significant aquifers both with and without the development of secondary permeabilities. Hydraulic conductivities for these formations typically range from 1.7 X 10^{-5} to 2.9 X 10^{-8} cm/sec. Water quality for this unit is good unless affected by previous activities and is a neutral bicarbonate type with some sulfate present.

The area to the south of the tailings impoundment and locally under the proposed waste rock dumps may be underlain by a Quaternary and earlier alluvial/colluvial aquifer system. Permeabilities in these formations are extremely variable and difficult to predict. Estimated values range from 10^{-3} to 10^{-6} cm/sec. Recharge to this system probably occurs from upslope runoff and local streamflow conditions, with a general flow direction toward the Jefferson River or the Boulder River. Water quality in this aquifer is probably variable, with poorer water quality associated with poor quality recharge sources, and with past land use practices.

The operation of the currently permitted tailings impoundment has influenced both the local groundwater quantity and quality. The failure of a slurry cut-off wall to contain impoundment seepage early in the impoundment life has led to the presence of cyanide in domestic and monitoring wells over a mile away. Remediation of potential leakage problems from Impoundment I has required continuous pumping from two separate arrays of pumpback wells. These two pumpback well arrays are operating in addition to the well array located between the impoundment and the slurry cutoff wall. The sustained pumping by all three of these arrays has altered the water table configuration in the impoundment area.

3. Water Rights

A review of the current filed water rights claims for the area around the Golden Sunlight proposed expansion indicates 28 filed claims are on record. Approximately half of these are listed as groundwater appropriations with flow rates of between 10 to 500 gpm, with water uses covering the full range of possibilities. Surface diversions in the area range from 2 to 12 cfs with diversions from both the Jefferson River and the Boulder River.

D. Vegetation

1. Background

The plant communities existing at the Golden Sunlight Mine (GSM) area today have developed in response to the semiarid continental climate, modified parent materials and new soils that have evolved in the area since the retreat of the Pleistocene glaciers 10,000 years ago (Ottersburg, 1981, p. 1).

The resultant communities are diverse due to the extreme variations in elevation, precipitation, slope and exposure, wind, evaporation, and soil characteristics found on the site across relatively short distances. Elevations in the area range from 4400-6600 feet. Estimated precipitation varies from as little as ten inches in the lower elevations in the rain shadow on the east side of the mountains to up to twenty inches at the higher elevations on the west side. In addition, effective precipitation is altered by: drifting snow in the winter; redistribution of moisture from the intense rainfall events that occur in the summer that exceed the soils infiltration capacity; and by the effect of varying slopes and exposures. Slopes range from zero to over 75 percent and occur on all aspects.

The most important soil characteristics affecting plant communities include reaction (pH), depth, drainage, texture, alkalinity (CaCO3 content), coarse fragment content, salinity and sodium content in lower soil profiles.

In addition to the natural influences on plant community development, in the last one hundred years plant communities in the area have been altered by livestock grazing and other agricultural activities, road and highway construction, and more recently from the current mining operation. Since 1975, GSM has disturbed over 833 acres. Only 45 acres have been revegetated because of continued expansion of the mine.

Table 7. Characterization of Existing Plant Communities in the Proposed Expansion Areas, Golden Sunlight Mine

Existing Plant Community	Slope	Percent Plant Cover	Aspect	Physical Setting	Relative Distribution in Expansion Area		
					Tailings	North	West
GRASSLAND COMMUNITIES							
Threadleaf Sedge	37%	69	S to W	Straight to undulating midslopes or coulee banks	common	limited	--
Blue grama/western wheatgrass	25%	58	All	Straight to concave midslopes on coulee banks and edges	common	--	--
Broom snakeweed bluebunch wheatgrass	56%	35	Warm	straight, midslopes or coulee banks	--	--	common
blue grama	8%	80	SE-SW	straight, lower slopes on terraces	common	common	--
western wheatgrass/ blue grama	9%	70	E-NE	concave to straight, lower slopes and runin areas	common	common	--
threadleaf sedge	Variable	71	Variable	convex sandy knolls knolls	common	--	--
needle-and-thread/blue grama/threadleaf sedge	9%	77	SE	straight midslopes on wet drainage benches	limited	common	--
idaho fescue/ bluebunch wheatgrass	40-50%	84 W, NW	Cool	straight or convex upper slopes	--	--	common
broom snakeweed	27%	59	W, N	straight to concave midslopes, overgrazed mountain foothill grasslands	--	--	common
SHRUB/GRASSLAND COMMUNITIES							
big sagebrush bluebunch wheatgrass	37%	71	S to E	straight, mid-to upper slopes, mountain foothills	--	common	common
big sagebrush/ idaho fescue	46%	92	E, W	straight, upper slopes on moutainsides	--	--	common

Table 7 - Characterization of Existing Plant Communities in the Proposed Expansion Areas, Golden Sunlight Mine

Table 7 Continued

Existing Plant Community	Slope	Percent Plant Cover	Aspect	Physical Setting	Relative Distribution in Expansion Area Tailings	 North	 West
mountain mahogany	44%	42	S, SW	straight, midslopes on chalky soil, limestone substrates	--	limited	--
rocky mountain juniper/bluebunch wheatgrass	38%	50	S to W	concave-slightly convex mid- to upper slopes, overgrazed western foothills	limited	--	common
rocky mountain juniper/blue grama/threadleaf sedge	variable 5-60%	86	variable	concave, mid to lower coulee bottoms and side slopes	limited	limited	--
OTHER MISCELLANEOUS COMMUNITIES							
douglas fir	52%	70	N to W	straight, mid- to upper forested mountainsides	--	limited	common
limber pine	52%	47	SW	convex, undulating to straight, midslopes on mountain foothills and coulee banks	limited	--	common
douglas fir/scree and forested rock outcrops	variable		variable	mountain ridges and and outcrops	---	---	--
bare ground or rock or rock	variable		variable	mountain ridges and outcrops	--	--	--

Grazing livestock have had an important but often more subtle effect on plant communities. Rangeland water developments, herbicide use to control shrubs, plowing and seeding to create improved dryland pastures, and fencing have altered plant communities (Prodgers, 1988, p. 20). Many of the existing plant communities are seral and vary from the potential communities that would exist on the site without livestock grazing.

Local vegetation communities have been changed by historic mining and mineral exploration disturbances; tree removal for mining timbers, fencing, and firewood; man-caused fires and suppression of wild fires; and introduction of non-native vegetation including several noxious weeds which have spread along roadways, around construction sites and rangeland water sources in the area.

2. Existing Plant Communities

Existing plant communities is be described for the three main disturbance areas (Table 7). Data presented has been interpreted by DSL from the vegetation and soil survey provided by GSM.

a. Proposed Tailings Impoundment Area

On relatively level benches, fans, and southerly exposures in the lower elevations, existing communities are dominated by short and midgrasses (and a sedge) characteristic of the mixed prairie grasslands, and shrubs including big sagebrush and rabbitbrush (Table 8). The coulee banks and rocky areas have the same plant communities, but also contain varying quantities of bluebunch wheatgrass, rocky mountain juniper and limber pine. The presence of shrubs and trees create the characteristic shrub-steppe appearance found in the area. North exposures have species more characteristic of the mountain foothill grasslands including idaho fescue and douglas fir. A dryland pasture seeded to crested wheatgrass has been established in a part of the proposed impoundment area.

b. North Waste Rock Dump Expansion Area

Although the soils and plant communities are significantly different than the tailings expansion area, the dominant plant species are essentially the same (Table 8). The foothill mountain grassland communities are more important and there is an increase in the quantity of trees with the increased moisture in the area. Species such as threadleaf sedge, blue grama, and needle-and-thread are reduced. Idaho fescue, bluebunch wheatgrass, western wheatgrass, limber pine, and douglas fir are increased. The area still has the appearance of a shrub-steppe but the mountains are closer and dominate the setting.

c. West and South Waste Rock Dump Expansion Areas

Soils on the west and south side vary significantly from the north and east side of the mountains. Slopes are steepest on the west side of the mountains and are in excess of 45 percent on half of the proposed expansion area. Dominance by the grasses characteristic of the mixed grass prairies have given way to dominance by grasses more characteristic of mountain foothill

Table 8. Major species in Proposed Expansion Areas and Relative Reestablishment Potential in Revegetated Communities (DSL Interpretation)

Dominant Species	Presence of Species in Existing Communities			Relative Reestablishment Potential	
Dominant Species	Tailings	North Dump	West and South Dumps	Seed Availability	Observed Reestablishment Potential
threadleaf sedge	x	x	x	none	low
blue grama	x	x		low	low
needle-and-thread	x	x		low	moderate
western wheatgrass	x	x		good	good
big sagebrush	x	x	x	low	low-moderate
bluebunch wheatgrass	x	x	x	moderate	moderate to good
fringed sagewort	x	x		undesirable	--
clubmoss	x	x	x	undesirable	--
rabbitbrush	x	x	x	low	moderate
prickly pear cactus	x	x		undesirable	--
prairie junegrass	x	x	x	low	low
idaho fescue	x	x	x	low	low to moderate
rocky mountain juniper	x	x	x	stock	low to moderate
kentucky bluegrass (non-native)	x	x		good	good
limber pine	x	x	x	stock	low
skunkbush	x			stock	low to moderate
red threeawn	x			undesirable	low to moderate
douglas fir	x	x	x	stock	moderate
crested wheatgrass (non-native)	x			good	good
broom snakeweed			x	undesirable	--
mountain mahogany			x	stock	low

Table 8. - Major species in Proposed Expansion Areas and Relative Reestablishment Potential in Revegetated Communities (DSL

Table 9. Relative productivity in Existing Plant Communities at Golden Sunlight Mine

RELATIVE PRODUCTIVITY

GRASSLAND COMMUNITIES	PRODUCTIVITY	RANGE CONDITION	STOCKING RATE
threadleaf sedge	550 kg/ha	fair	0.15 AUM/A
blue grama/western wheatgrass	400 kg/ha	fair	0.15 aum/a
broom snakeweed/bluebunch wheatgrass	300 kg/ha	good	0.10 aum/a
blue grama	350 kg/ha	fair	0.15 aum/a
western wheatgrass/blue grama	600 kg/ha	good	0.25 aum/a
threadleaf sedge	350 kg/ha	fair	0.15 aum/a
needle-and-thread/blue grama/ threadleaf sedge	500 kg/ha	good-fair	0.20 aum/a
idaho fescue/bluebunch wheatgrass	1,000 kg/ha	good	0.40 aum/a
broom snakeweed	--	poor	-.--
SHRUB/GRASSLAND COMMUNITIES			
big sagebrush/bluebunch wheatgrass	900 kg/ha	good	0.2-0.25 aum/a
big sagebrush/idaho fescue	1,000 kg/ha	good	0.40 aum/a
big sagebrush/western wheatgrass	600 kg/ha	fair-good	0.20 aum/a
big sagebrush/needle-and-thread-red threeawn	800 kg/ha	fair-good	0.2 aum/a
mountain mahogany	500 kg/ha	--	-.--
rocky mountain juniper/bluebunch wheatgrass	500 kg/ha	fair-good	-.--
rocky mountain juniper/blue grama/ threadleaf sedge	300 kg/ha	--	0.15 aum/a
OTHER MISCELLANEOUS COMMUNITIES			
douglas fir	250 kg/ha	--	-.--
limber pine	--	--	-.--
douglas fir/scree and forested rock outcrops	--	--	-.--
bare ground or rock	--	--	-.--

Table 9. - Relative productivity in Existing Plant Communities at Golden Sunlight Mine

grasslands (Table 8). Because of the increased moisture on the west side, trees are more common on the higher elevations primarily on the northerly aspects.

3. Productivity

a. Range Condition/Productivity/Stocking Rate

Range condition is generally fair to good depending on distance to livestock water (Table 9). The estimated production of non-woody vegetation varies from 0-1000 kg/ha with 500 kg/ha being a reasonable average. Plant canopy coverage varies from 35 to 92 percent, with 70 percent being a reasonable average (Table 7). Estimates of animal unit months (AUM) of forage for livestock per acre varied from 0 - 0.40 aum/acre. A reasonable average would be 0.15 - 0.20 AUM/acre (Table 9).

b. Utilization by Livestock/Wildlife

The grass dominant character of the plant communities favors cattle and horse use over sheep. Antelope use in the area is more extensive than deer. Deer utilize the area more in wintertime, especially the big sagebrush communities. There is an edaphic plant community in the tailings area on limestone parent materials and chalk soils derived from limestone that is dominated by mountain mahogany. This plant community receives extensive winter use by deer. Fortunately, only a small acreage of this type would be disturbed by the proposed tailings expansion area. Deer may use the timbered coulees and ephemeral drainages more for shelter and access to the adjacent irrigated alfalfa fields south of the expansion area, than for forage.

4. Noxious Weeds

Noxious weeds are not a major problem in the proposed new disturbance areas (R. Prodgers, 1988, written communication). Four weeds in the present permit boundary are considered noxious by the Madison-Jefferson County Weed Control Board. The four weeds in order of decreasing priority of control are: spotted knapweed, whitetop, leafy spurge and canada thistle. All of the species have the potential for native species displacement.

GSM has been trying to control noxious weeds in the area since 1984 (GSM Noxious Weed Report to DSL, 1988, written communication).

5. Rare and Endangered Species/Species List

No rare and endangered species were found in the 1988 survey of the proposed expansion areas (R. Prodgers, 1988, written communication).

The total number of species found in the study areas during the vegetation survey equalled 152. Of particular importance, the total number of forbs and subshrubs reported was 112. The shrub/grassland communities were particularly forb rich.

E. Wildlife

The southern Bull Mountains support a small elk herd. This herd was displaced northward by initial mine opening in 1981. Survey information indicates that approximately 50 elk winter in the vicinity of Black Canyon and a lesser and more variable number are found around Black Butte. These areas are two to four miles north of the proposed disturbance. Elk use during other seasons has not been adequately documented, but hunting season reports have placed elk in the Conrow drainage and just north of the Electronic site in section 18 (T. Carlson, 1989, written communication).

Mule deer use in this area has not been quantified, although the habitat is considered suitable for the species. The sagebrush-grassland over much of the area provides good winter range and the rough, broken country at higher elevations is good habitat during other seasons (T. Carlson, 1989, written communication).

Antelope winter range is located south of Red Hill. There have also been 20 to 30 head reported summering south of Red Hill in sections 27 and 28.

Smaller mammals which are common on the proposed disturbance area include the snowshoe hare, white tailed jackrabbit, two species of chipmunk, the columbian ground squirrel, red squirrel, wood rat, two species of mice, three species of voles, porcupine and striped skunk. Coyotes and bobcats are common predators in the area. Twenty-one species of passerine birds potentially nest in the area, and two species of snake, the prairie rattler and bull snake, are common.

Although quantified information of waterfowl use of the nearby Jefferson and Boulder Rivers is not available, waterfowl use of these rivers in the vicinity of the mine is significant. Local breeding populations of Canada geese associated with the Jefferson and Boulder Rivers have increased in recent years as they have throughout most of their range. This area is also a major migration corridor for Swan and snow geese (T. Carlson, 1989, written communication). Ducks have landed on the impoundment and would be attracted to the new impoundment as well.

The Jefferson River between Big Pipestone Creek and the mouth has been designated a high value sports fishery, providing 1,401 fisherman days/year/10 km. Rainbow trout are common, whereas brown trout and whitefish are abundant (Trout, 1988). A three-year average population survey estimates 293 adult (3 years +) browns/mile below the mine site (Willow Creek to Three Forks) and 350 adult browns/mile above the mine site (Hells Canyon Creek section). This population experiences unusually high adult mortality, probably related to summer dewatering and severe winter icing in some sections of the river (DFWP, 1986).

The Boulder River near the mine has been designated a substantial sports fishery for the stretch from Cottonwood Creek to the Jefferson River (Trout, 1988, p. 33). The lower Boulder is used for spawning by brown trout.

There is no known occupied habitat of any of the four listed terrestrial, threatened or endangered species in the vicinity of the mine. Two avian listed species, the bald eagle and the peregrine falcon, are likely to occur in suitable habitat in the general area.

Bald eagles prefer to nest near open water, hence it is very unlikely that this species would occur in the mine area. Bald eagles are likely to occur on the Jefferson and Boulder Rivers during the winter. Similarly, peregrine falcons are not likely to find nesting cliffs on the mine. The Jefferson River does contain used peregrine habitat, so they may occasionally occur in the mine vicinity.

F. Air Quality and Climate

Golden Sunlight has monitored air quality around the existing operation for the last eight years. Total suspended particulate (TSP) concentrations have been well below Montana and federal ambient air quality standards. The following table summarizes the TSP data collected over the last four years.

Table 10 - Annual Total Suspended Particulate Concentrations, Golden Sunlight Mine (micrograms/cubic meter)

	Upwind Site			Downwind Site		
Year	Max.	Second High	Mean	Max.	Second High	Mean
1984	32	27	10	56	37	17
1985	57	49	15	78	74	21
1986	51	50	17	89	73	26
1987	96	39	21	120	64	24

The basis of the particulate standards has recently been changed from TSP to PM-10 (particulate matter with a diameter less than 10 microns). The following is a listing of both the old and new standards.

Table 11 - Montana and Federal Particulate Standards

Pollutant	Montana Standard	Federal Primary Standard	Federal Secondary Standard
Total suspended particulates (repealed)	75 ug/m^3 annual average 200 ug/m^3 24-hour average	75 ug/m^3 annual geometric mean 260 ug/m^3 24-hour average	60 ug/m^3 annual geometric mean 150 ug/m^3 24-hour average
Particulate matter less than 10 microns (PM-10)	50 ug/m^3 annual average 150 ug/m^3 24-hour average	50 ug/m^3 annual average 150 ug/m^3 24-hour average	None None

Current air pollution sources in the area include the existing mining activities (haul road traffic, blasting, drilling, ore and waste handling, and

wind erosion of exposed areas) other vehicle traffic, and agricultural activities.

The climate of the area is classified as semi-arid intermountain and is typical of southwestern Montana. The continental climate characteristics of the region are modified by the local ranges of the Rocky Mountains. Pacific Ocean air masses, drainage of cooler mountain air into the valleys, and the shielding effect of the mountains reduce the temperature changes typical of a true continental climate.

Annual precipitation ranges from 12 to 20 inches with peak amounts occurring in May and June. Pan evaporation has averaged 44 inches per year in the May 1 to September 30 period.

The average annual temperature is about 45 degrees F. The highest average monthly temperature measured at Cardwell from 1983 through 1986 was 71 degrees F in July 1985. The lowest average temperature was 11 degrees F in December 1983. Temperatures range from about minus 40 degrees F to 100 degrees F. Freezing temperatures can occur as late as mid-June and as early as September.

Prevailing winds are from the west. The wind direction is from the west-southwest through west-northwest over 47 percent of the time. The westerly winds also have the highest average wind speed at 13.6 miles per hour. Highest wind speeds normally occur in January and the lowest in May and June.

G. Transportation

The Golden Sunlight Mine is located approximately 5 air miles from the city of Whitehall, Montana. The mine's gravel access road connects with Montana state Highway 2 East, a paved frontage road to Interstate 90. Local access to ranches to the west of the mine is provided by gravel county roads which connect to the frontage road.

During the operations, the mine access road is treated with dust suppressant to control dust. At reclamation, Golden Sunlight has committed to reshaping existing internal mine roads. Road berms and some downslope material would be brought back towards cut faces and outside crest materials rounded. Revegetation of roads would include both grassland/forb species and trees/shrub mixtures.

H. Socioeconomics

Golden Sunlight has been in operation since 1975. Employment at the mine is approximately 195 workers. Most employees live within the northern portion of Jefferson County, in Whitehall and Cardwell, in the area around Butte, in Silver Bow County, or in Silver Star and Harrison, in Madison County. The last major expansion of the mine, in 1981, occurred during shut-down activities of Anaconda Copper Company properties in Butte and Anaconda. The expansion took place prior to the enactment of the Hard Rock Impact Act and no Impact Plan was required. According to correspondence with local government officials and school personnel, increasing mine employment posed no threat to existing local services and no deleterious impacts were anticipated as the mine expanded to

its current, permitted size. Both Cardwell and Whitehall school districts operated well below the capacity of the elementary and high school facilities.

During the time the mine has been in existence, federal, state and local taxes have been paid. In addition to federal and state income taxes paid on an annual payroll of over $5 million, Golden Sunlight pays five separate state taxes. These are: the Gross Proceeds Tax, the Resource Indemnity Trust Tax, the Metalliferous Mines License Tax, the Corporation License Tax, and Property Tax. Keyed to production and property values, these taxes have been paid on approximately 450,000 ounces of gold produced from 1983. In 1987, total tax revenues exceeded $1.5 million. In addition to these annual taxes, a portion of the Metalliferous Mines License Tax goes into an earmarked subaccount. These funds would be available through grants or loans to Jefferson County and other local county government units at mine closure. As of the end of the 1987 production year, Golden Sunlight Mine has paid over $600,000 into this account.

I. Cultural Resources

1. Prehistoric Activities

Portions of the mine area were surveyed for cultural resources in 1980. In 1985, the investigation was broadened to include all or portions of Section 17, 20, 23, 28, 29, 32, and 33, Township 2 North, Range 3 West, M.P.M. As a result of this investigation, seven prehistoric sites and twenty-three minimal activity locales (MALs) were identified in the project area. Site types included open occupation sites, material procurement sites, and stone circle sites. No historic sites were located.

One site, the Sheep Rock site (24JF292), was identified as meeting the criteria for nomination to the National Register of Historic Places. The site, located in the NW¼SW¼SE¼ of Section 17, T2N, R3W, represents a multi-component habituation site located on an alluvial terrace at the base of Sheep Rock (GCM Services, 1985). Established in close proximity to a perennial spring, the site includes a number of small rock shelters on Sheep Rock.

The Coulee Ring Site (24JF766) is located in the NW¼SW¼NW¼ of Section 33, T2N, R3W. Located adjacent to a spring, the site consists of a stone circle. It was tested, mapped and recorded, and did not meet eligibility criteria.

2. Historic Activities

The Golden Sunlight Mine area has been the site of periodic mining activity since the 1890's when the first claim was staked (Steere, 1980, 50 p.). Ore was processed in a series of mills, including a 40-ton cyanide mill constructed in 1906. For the period from 1980 to 1950, the estimated gross value of the total production of the mine (including gold, silver and copper) exceeded $3 million.

In 1985, Golden Sunlight and the State of Montana exchanged 1642.56 acres of state-owned land for a similarly-sized tract of privately-owned land. The state-owned land exchange site was included in the second, extensive cultural resource survey. As a result of the findings of this survey and as a condition

of the exchange, Golden Sunlight and the State of Montana entered into a Memorandum of Understanding (MOU). The conditions of the MOU included annual DSL inspection of 24JF292, a "significant antiquities site", notification of the State Historical Preservation Office (SHPO) by DSL if any adverse impact to the site has occurred, and a commitment that, should any mine-related disturbance of the site be proposed, appropriate mitigation measures would be promptly conducted (full documentation of the site) by Golden Sunlight.

J. Aesthetics

The natural landscape varies from rugged, sparsely vegetated rocky foothills with some scattered pine and juniper trees to rangegrass-covered foreland areas. Elevations of disturbed areas range from 6500 feet on the west to 4400 feet on the east.

Currently, waste rock dumps and the tailings impoundment facility stand in contrast against the land forms and colors of the natural landscape. The waste dumps are constructed at the angle of repose (1.5h:1v) with flat tops. Slope distances are presently less than 600 feet with heights under 400 feet. The waste rock is off-white to grey to rusty brown in color, and completely uniform in textural appearance.

Waste rock dumps are just beginning to expand onto the west slopes where they are visible from Whitehall. The tailings impoundment and north waste rock dumps are visible from Interstate 90 and Montana State Highway 69. The south waste rock dump is visible from Interstate 90.

CHAPTER IV - CONSEQUENCES

A. Geology

Waste dump expansion through mining Stage V would continue with deposition in existing dump complexes, and development of additional dumping elevations on the west side of the mountain. Geologic information indicates that all foundations, with the exception of the Midas Slump, are competent; operational stability should be further enhanced by reduction of dump slopes to 2h:1v for reclamation.

Foundation failure in the north dump complex develops from overloading soft clays within the Midas Slump, resulting in deep circular shearing, tension cracks in the dump top and face, and upheaval of slump material ahead of the dump toe. Deformation is through slow creep that responds to dumping rates, and is primarily an operational concern. Golden Sunlight has implemented monitoring and mitigation programs that include topsoil salvage in advance of deformation below the dump toe, regular surveys to determine creep rates and response to dumping sequence, and geologic mapping to establish the extent of the Midas Slump landslide material. In addition, proposed expansion of the north dump complex is to incorporate a dumping scheme that would surround the Midas Slump material and form abutments along the flanks and toe prior to deposition of additional waste rock on the landslide.

The effects on reclamation may be inconsequential if operational containment of the Midas Slump is successful. In the event that the project does not go to scheduled completion, stabilization of the dump surface may require considerable time and reclamation effort. The most serious environmental consequences would occur if the extent of the Midas Slump material or the degree of creep is misinterpreted, causing potential flow into and plugging of the drainage immediately to the north and east of the proposed dump limits (Sheep Rock drainage).

Pit expansion through mining Stage V will produce an expansive and over-steepened scarp in the mountain. The 2000-foot highwall on the west would probably experience some minor sloughing and structural wedge failure over time. However, rock falls from the pit wall should be contained in the depression of the pit bottom, relieve wall rock stress concentrations, and eventually result in a flatter, more stable configuration.

The centerline method of raised embankment construction is being used on the existing impoundment, and would be employed on the proposed impoundment. Centerline construction is well suited for reactive or toxic tailing material, for which controlled drainage of tailing effluent is necessary. Control of saturation levels and compaction of embankment lifts in centerline dams provide stable static conditions and generally good seismic resistance. Centerline embankments cannot be used to permanently store water or totally saturated material, but can handle temporary flooding or fluctuations in phreatic surfaces. Although impounded tailings slimes are at or very near saturation during the depositional life of the project, internal drains and pervious materials in the main embankment control phreatic levels and maintain stability during operations.

Golden Sunlight proposes that both the existing and proposed facilities permanently impound direct precipitation and upstream runoff for reclamation. Because of the small size of tailing particles and the effects of surface tension, tailing slimes would retain enough interstitial fluid to be near saturation. Periodic recharge during storm runon is expected to create fluctuating levels of saturation within the tailings deposit, and subsequent discharge through the drain systems.

Reclamation diversion systems to minimize flow into the impoundment basins, and prevent runon and tailing recharge, were originally recommended by the design consultants for both impoundments (SHB Job No. E80-89, 1980, pp. 12-14; SHB Job No. E87-13, page 3). In addition, the impoundment drain systems were neither designed nor built to function permanently (SHB Job No. E80-89, 1981, pp. 3-4). In the existing impoundment a recommended blanket drain system was replaced by less extensive finger drains. Present drain discharge of 40 gpm is multiples less than what is estimated to be seeping through the clay liner, indicating that drain function may already be diminished. As drain function decreases or ceases, it is assumed that driving head would increase uncontrolled flow through the foundation. In the proposed impoundment, installation of a synthetic liner would likely increase dependence on drain function for post-operational stability.

Stability analyses for both impoundments assume that the phreatic surface is minimized in the embankment. In the existing impoundment, an adequate design factor of safety is sensitive to elevation of the phreatic surface; however, operational monitoring of piezometer wells in the dam toe indicate that phreatic levels are being controlled by foundation seepage. Even with complete drain failure, it is felt that sufficient uncontrolled seepage through the foundation would preclude embankment saturation and mass instability.

The proposed impoundment is to incorporate a blanket drain of cycloned sands beneath the main embankment to facilitate finger drain function. In addition, the drainage area above the impoundment is considerably less than that above the existing impoundment. Reduced runon potential and pervious material in the embankment is expected to result in moderate and temporary fluctuations in phreatic surfaces.

Mass instability is not anticipated to be a significant consequence of the limited proposal for reclaiming the tailing impoundments. Should revegetation and natural encapsulation of the tailing surface fail, however, periodic recharge and decreased drain function would likely result in uncontrolled seepage, piping and erosion in the embankments' toes and wing dikes.

B. Soils

1. Soil Salvage

Soil salvage operations and soil storage have several unavoidable, usually deleterious effects. Soil handling destroys horizon development and structure, and homogenizes soil horizons and soil types, destroying millennia of soil development. Handling operations may cause compaction and loss of tilth.

Long-term storage further reduces soil viability by causing the death of soil microorganisms and plant propagules.

Depth of soil is one of the principal factors determining productivity, density, and canopy cover of vegetative communities. Deeper soils inherently are better for plant growth than similar shallow soils because of the increased availability of water for plant growth. USDA-SCS grazing guides for the foothills and mountains biome indicate stocking rate reductions of 30 to 310 percent for shallow and very shallow range sites as compared to deep soil sites. These sites are defined as having soils with rooting depths of less than 20 inches to less than 10 inches, respectively.

Reclaimed mined land soils also show significant decreases of vegetative productivity and root development with decreasing soil depth (Redente and others, 1982, pp. 109-122, McGinnies and Nicholas, 1980, pp. 682-685). For productivity of most range grasses, optimal soil thicknesses have been noted to be in the range of 12 to 40 inches (DePuit, 1988, p. 102).

GSM has proposed a soil salvage plan based on soil suitability criteria adapted from Schafer (1979, Vol. 2, pp.67-74). Table 12 summarizes the major discrepancies between DSL and GSM concerning the suitability of soil for salvage and reclamation use.

Salvageable soils at GSM have no major textural limitations for use in reclamation. Several horizons are identified by GSM as having limited utility because of inherent erosiveness of sandy soils or high bulk densities because of high clay content, but homogenization of horizons during salvage and two-lift soil salvage would negate any undesirable properties of these limited horizons.

GSM has proposed salvage of soils up to 35 percent coarse fragments. DSL considers soils with up to 50 percent coarse fragments suitable for reclamation.

Slopes of 2 horizontal to 1 vertical (50 percent) are commonly accepted as being the limit of safe equipment operation. GSM and DSL are in agreement on this parameter.

Table 12 - Discrepancies in soil salvage between GSM and DSL

Calcium carbonate content can be a limiting factor of certain soils, insofar that excessive calcium ties up phosphorus and inhibits plant water absorption, resulting in a less fertile and droughty soil. However, calcium values of soils at GSM are not sufficient to preclude salvage. Moreover, since the calcareous soils would be replaced over potentially acid-producing waste rock dumps and tailings, use of calcareous soils should be considered a beneficial mitigation, increasing the buffering capacity to potential acidification.

Extremes in soil reaction (pH) are commonly accepted as undesirable in soils used for reclamation. However, as with textural constraints, the few instances of extreme pH values would be homogenized with other soils during salvage operations.

2. Tailings Characteristics

The tailings which report to the cyclone and the impoundment are high in pyritic sulfates, a function of the character of the ore. They have a particle size of less than 35 mesh from the milling circuits. Apparently the tailings initially have relatively high pH (8.0+) values as a result of lime additions in the leaching circuit. Concentrations of several elements have been reported including: aluminum, 34.0 ppm; iron, 530.0 ppm; barium, 19.8 ppm; copper, 25.41 ppm; lead, 0.11 - 0.25 ppm; magnesium, 14.75 ppm; calcium 20.0 ppm; and sodium, 50.0 ppm. Of these, only aluminum shows concentrations in excess of reported plant toxicity levels, 14 ppm for aluminum (Gough and others, 1979, p. 4). Cycloning of the tails separates the sand fraction, which is used for dike construction, sending the remaining slimes into the tailing impoundment. The proposed reclamation plan calls for depositing whole mill tails at the rear of the impoundment as final closure is approached, leading to the development of a veneer of unknown thickness of whole mill tails overlying the clayey "slime" mass.

3. Revegetation Trials

GSM conducted revegetation trials on the first tailings impoundment from 1985-1988 (Western Reclamation, Inc., and GSM, 1988, 21 p.). A small (120 by 240 by 4 foot) tailings pond was constructed above the level of the active tailings disposal area. The pond was filled with tailings during four days between January 30, 1984 and March 30, 1985.

The study plot design consisted of four tailings amendment treatments and ten seeded species. The entire area was fertilized with 100 pounds 0-0-60, 250 pounds 0-45-0, 200 pounds 0-0-0-15, and 50 pounds 21-0-0-24 per acre. The fertilizer was incorporated into the top six inches of tailings.

The high sodium content and potential acid producing pyrite particles in the tailings led to the selection of a topsoil treatment and two treatments utilizing calcium and woodchips on hay and a bare tailings control. Topsoil was placed to a depth of 4 inches. Calcium was spread and incorporated into the tailings before the wood chips and hay were applied, at a rate of 5 tons per acre.

Results of the revegetation trials show that a thicker layer of soil is needed to reclaim the tailings. The four-inch layer of soil which was emplaced proved to be an inadequate growth medium for plants, providing limited soil moisture, inadequate fertility, and an inadequate barrier over the pyritic tailings. Although initial plant establishment over four inches of soil appeared satisfactory, within four years plant production and canopy cover declined and plant mortality was evident.

Sufficient neutralization of the tailings may allow them to support growth. However, placement of a waste rock cap and subsoil and topsoil over the tailings would provide a better opportunity for revegetation and prevent erosion of untreated tailings.

Acidification of the tailings in the test plots by chemical and bacterial oxidation of the pyrite occurred in a period of five years with resultant lowering of pH values below those suitable for plant growth. Reported values were recorded in the range of 2.2 to 7.5. Highest values occurred under topsoil. Salts have leached downward. Hydrogen ion concentrations (pH) decreased with depth and conductivities, sodium absorption ratios (SARs), and total sulfur and sulfate sulfur concentrations have increased with depth (Western Reclamation Inc. and Golden Sunlight Mines, 1989, Appendix B, page 1).

The study concludes a greater depth and quality of growth medium is needed to successfully establish vegetation on the tailings than was examined in the test plot studies.

4. Tailings Impoundments

a. Second Tailings Impoundment

Soil salvage operations, as proposed by GSM, would salvage sufficient soil from disturbed areas of the tailings impoundment to insure replacement of 6 to 12 inches of soil for revegetation. GSM has proposed salvaging 390,600 bank cubic yards (bcy) from the 271-acre tailings impoundment area. This would result in the wastage of 77 percent of suitable soil materials (Table 4) which would be inundated by the tailings impoundment.

The wastage of this soil has serious implications towards the reclamation of the first tailings impoundment as well as the second. The 1,308,000 bcy which would be inundated in the second impoundment, plus that soil proposed for salvage, would allow the replacement of more than two feet of soil on both impoundments. An increased thickness of soil would materially improve the chances of successfully establishing a self-sustaining ecosystem. Two-lift salvage and replacement of soil for the impoundments is practical and eliminates unsuitable characteristics of subsoils. Replacement of a thin layer of soil over reactive tailings has been shown to be ineffective. Loss of this soil would severely limit reclamation options should the proposed plans fail.

Without a waste-rock cap or adequate neutralization of the acid tailings, plant vigor and diversity following revegetation would be significantly impaired by up-ward migration of salts and acid. The four feet of tailings which were deposited for the test plot study contain a much higher sand

fraction than would be expected in the surface four feet of tailings Impoundment II. GSM, however, has committed to placing whole tailings on the surface of Impoundment II at the end of mining. Nevertheless, it is unknown how thick the final layer of whole tailings would be or if it is possible to evenly cover the entire impoundment surface. The sandy clay loam texture of the whole tailings may inhibit plant growth and root development, especially if the layer is shallow and underlain by the clayey slime tailings within the potential rooting zone. Despite the observed downward movement of salts and acid in the test plots, both textural classes exhibited by the tailings have the potential for capillary rise of toxic solutions of metals, salts, and acid which could alter the physical and chemical characteristics of the replaced soil. Furthermore, the elemental sulfur and fertilizer amendments incorporated into the test plots, which are not included in GSM's tailings reclamation plan, may be responsible for lowering the pH, mobilizing sodium, and inhibiting a sodic horizon.

The company has proposed capping tailings Impoundment II with a two-foot layer of waste rock, if necessary, to isolate the tailings from the root zone. If effective, this break would prevent the contamination of the replaced soil from direct and indirect contact with the tailings. The rock layer may prevent blowing or washing of tailings in the event of revegetation failure.

However, the fine particle size, fluid retention properties and low bearing strength of the tailings slimes may limit overall reclamation performance. Dumping and dozing of cap materials may result in mixing of waste rock and tailings, seriously inhibiting the effectiveness of the cap as a barrier to capillary rise or direct contamination of the replaced soil layer by the tailings. The two-foot waste rock cap and potential inability to regrade the tailing surface may result in post-settlement low areas, ponding following precipitation and runon events, and subsequent contamination of the reclamation soil layer by tailings solution.

GSM has not proposed a rock cap or neutralization of the sand tailing of the dam face and wing dikes. These tailings are assumed to have similar reactive properties to the tailings within the impoundment. Rill and gully erosion and acidification of replaced soil would cause revegetation failures on the dam face and wing dikes. Rill and gully erosion is likely to develop before vegetation is established, thereby potentially washing tailings from the embankment face. Acidification of the replaced soils would exacerbate rill and gully erosion.

The replaced soil would be relatively thin. Some soil would probably be lost into the voids of the waste rock capillary break, further diminishing the depth of soil available for plant growth. This would result in diminished vegetative production with a resultant increased probability of soil erosion.

There is an unquantified possibility of acidification of the replaced soil from contact with the waste rock cap. Several factors would affect the probability of soil acidification including origin and mineralization of the rock, size gradation of the rock, and hydrologic regime.

b. First Tailings Impoundment

Reclamation of the original tailings impoundment, as permitted, would entail placing approximately 97,000 bcy of salvaged soil over the 200-acre tailings impoundment area, achieving a replacement depth of between three and six inches of soil over tailings. There is a high probability that the replaced soil would ultimately be impacted by acidification, or upward migration of salts and sodium from the unamended tailings. This change in soil chemistry would first inhibit and ultimately prevent plant growth.

Acidification of this thin soil layer appears certain. Acidification of the soil would kill establishing vegetation. Ultimate revegetation failure on the first tailings impoundment is assumed, with resulting blowing of contaminated soil and tailings.

5. Waste Rock Dumps

a. Reclamation Constraints

There would be two types of surface to be reclaimed on the waste rock dumps, flat tops and benches, and 2h:lv slopes. The underlying material would be coarse waste rock, with size gradations varying from gravel to boulders in size.

The physical limitations to plant growth of the waste dumps can be effectively overcome by placement of an adequate thickness of soil over the rock to enable a self-sustaining vegetative community to establish. If soil salvage proves inadequate to completely cover the rock with an effective depth of at least 6 to 12 inches, establishment of vegetation is unlikely.

The steep dump slopes present an additional challenge to soil stabilization and revegetation efforts in that they would be subject to water erosion and to the unsheltered effects of strong winds. These would be particularly harsh sites to reclaim and success is not assured.

There is an additional complication, in that the rock may prove to be acid-generating. If acidification of the replaced soil occurs, ultimate revegetation failure can be assumed, unless a neutralizing amendment is used.

The waste rock dumps north and east of the pit would cover approximately 309 acres after final slope reduction. Approximately 160,000 bcy of soil material has been salvaged from the north dump area. GSM has proposed salvaging soil in this area to an average depth of eight (8) inches, salvaging 276,100 additional bcy of soil. Depth of salvageable soil on the east side varies from 11 - 50 inches. The proposed soil salvage plan would waste 80 percent of available soil (Table 5).

Salvaged soil, together with that material already stockpiled, would allow for the replacement of 10 inches of soil over approximately 309 acres of waste rock dump on the north side. This would provide for a minimal rooting depth for plant growth which would probably be adequate to sustain adapted species.

The waste rock dumps south and west of the pit would cover approximately 416 acres after final slope reduction. Approximately 180,000 bcy of soil material have been salvaged from the area of the south dump. GSM has proposed salvaging soil in this area to an average depth of eight inches, salvaging 166,300 additional bcy of soil. Depth of salvageable soil on the west side varies from 6 - 13 inches. The proposed soil salvage plan would result in the wastage of 82 percent of available soil (Table 6).

Salvaged soil, together with the material already stockpiled, would allow for the replacement of six (6) inches of soil over approximately 416 acres of waste rock dump on the west side. This would provide for a barely adequate rooting depth for revegetation.

Acidification of the replaced soil from contact with acid-producing waste rock is a real but unquantified possibility. Acidification of the soil could result in a loss of vegetative cover with resultant erosion and loss of the replaced soils. The probability of acid production from the waste rock would depend on the origin and acid producing potential of the rock and the hydrologic regime on the dumps. If acidification proves to be a problem, the dumps would ultimately be bare rock with scattered pockets of acidified soil. Most of the contaminated soil would blow or wash away onto adjacent areas.

Some replaced soil would be lost into voids in the waste rock. Erosion off of the steep dump slopes would also be a factor causing soil loss and retarding revegetation. Wind erosion would likely be a more significant factor on the exposed slopes of the west side. Loss of soil to wind and water erosion is inevitable. The result would inevitably be areas devoid of soil on the dump slopes.

C. Hydrology

The development of Impoundment II would alter the hydrologic character of the area. Runoff that formerly flowed from the drainage area would be captured by the proposed structure and diverted to the mill. The drainage basin has an area of approximately 320 acres. The loss of these ephemeral water courses is expected to have only very localized effects and is not anticipated to influence either the alluvium recharge or surface flow in the Jefferson River. Impoundment II may reduce local aquifer recharge by sealing off areas or by capturing runoff that recharged the local groundwater system. The relatively small size of the disturbed area compared to the total groundwater recharge system suggests that this impact would be minimal.

Constructing of Impoundment II would necessitate installing new pumpback wells on the crest of the wing dike on the east side of Impoundment I. This array may depress the phreatic surface in areas previously not affected by the present pumpback system. These effects are expected to be localized and would not extend to any currently claimed groundwater sources.

Construction of Impoundment II is not expected to affect water quality downgradient of the impoundment during operations since seepage would be

controlled by the liner and seepage collection system. No surface discharge of tailings fluid is expected to occur during the operational life.

1. Reclamation

Proposed reclamation of the tailings impoundment area includes a self-sustaining vegetation community and prevention of water pollution. The acid-producing potential of the tailings has been documented in acid/base accounting analyses, discharge from the Ohio Adit, and the results of the tailings reclamation studies GSM is currently conducting.

Low pH values tend to mobilize metals available in the tailings, which could degrade groundwater and surface water. Reclamation of these acid-generating materials would require control of water and oxygen. This generally involves limiting the amount of water recharge, oxygen, or neutralization of the produced acid.

The potential recharge of the tailings was analyzed using a mass balance approach. Details of the model inputs and assumptions are presented in Appendix A. The model analyzes the amount of water exiting the soil horizon assuming that a healthy, self-sustaining vegetative cover is established in the reclaimed soils. Water input to the replaced soil, the waste rock cap and the tailings material are expected to be controlled more by specific storm intensities than mean annual values. Water requirements to reach saturation were based on antecedent conditions of wet years, average years and drought years. Evaporation, while high in the project area, is expected to be substantially less at depth in the soil.

Water exiting the reclaimed soil horizon would flow through a two-foot zone of mine waste rock overlying the tailings. The capillary movement of water through this zone would depend on the size gradation of the cap material and the rate of outflow from the soil. It is assumed that all water exiting the soil horizon would recharge the tailings.

Interstitial water within the tailings is expected to drain downward as the tailings impoundment is decommissioned. This gravity drainage would lower the moisture content of the tails from saturation (approximately 28 percent) to a water content of specific retention (field capacity)(estimated at 20 percent) based on estimated size gradation of the tails). The rate of water movement at moisture content below saturation is a complex process and is dependent on a number of factors, including material properties, anisotropies and inhomogeneities in the system. Information on the physical properties of the Golden Sunlight tails was not provided in the application. However, it is anticipated that the unsaturated hydraulic conductivity of the tailings would be less than the estimated saturated hydraulic conductivity (10^{-5} cm/sec). Given the estimated size gradation of the tailings material and the estimated hydraulic conductivity of the system, it is estimated that evaporation would have a limited influence on the moisture content of the tailings mass, especially at depth. It is assumed that most of the tailings will have a moisture content close to specific retention. This implies that water reaching the impoundment would eventually seep out the impoundment base.

Figure 5, Mass Balance Calculations

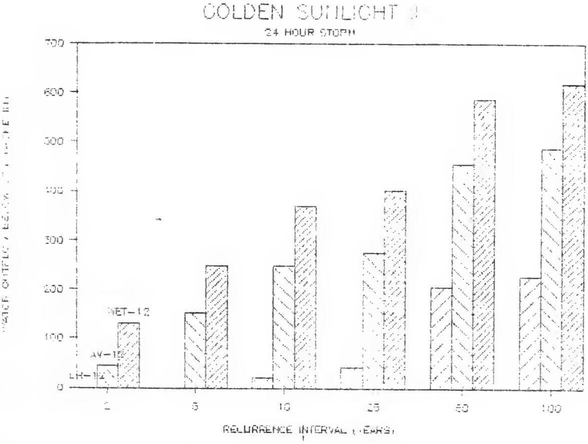

Figure 5. The results of the mass balance calculations for proposed reclamation plan for impoundment II. The labels "AV-12", "DR-12", and "WET-12" refer to antecedent conditions of average, wet and drought. The value 12 corresponds to a replaced soil horizon thickness of 12 inches.

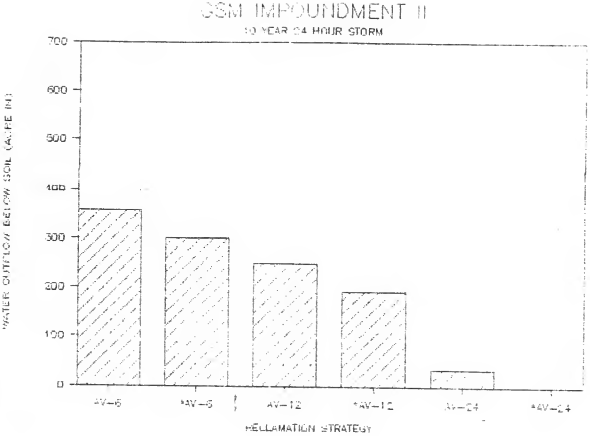

Figure 6. The results of some alternative reclamation strategies for impoundment II using average antecedent values (AV). The values following the "AV" are the replaced topsoil depths (6, 12, or 24 inches). Labels with a preceeding asteric indicate diversion of all upslope runon, values without a preceeding asteric assume no diversion.

The rate at which water would seep from Impoundment II is a function of physical and hydrologic variables in the tailings and waste rock cap materials. Modeling of the rate of seepage from Impoundment II is considered inappropriate due to the limited amount of data. The lack of data to model seepage rates does not alter the results of the mass balance calculations. The potential seepage rates may be reflected by the current seepage through and under Impoundment I. The rate for both underflow and flow through the tailings is approximately 400 gpm.

The results of the mass balance calculations are presented in Figure 5. Results suggest that recharge of the tailings can be anticipated under a variety of potential storm events. If significant recharge of the tailings impoundment occurs, increased seepage from the impoundment can be anticipated.

The tailings have a proven ability to generate acid based on the results of the tailings reclamation studies conducted on Impoundment I and the quality of water currently draining from the Ohio Adit. Limited information is available on the expected quality of the potential water seeping from the proposed impoundment. Results of a variety of extraction analyses on the tailings are presented in Table 13. These results were developed using a variety of methods and cover a period of time. The results of the 1980 and 1984 analyses were used to determine the potential seepage water quality. The 1984 data were collected using the DTPA procedure. This method uses a pH (7.8) and probably underestimates metals values in an acidic environment. The 1980 data were obtained from a test sample using a 1.3 percent weight to volume acid leach. Unfortunately, the exact methodology and the nature of the acid used were not provided. The 1980 data appear to represent a set of reasonable metals values in an acidic environment. Based on this limited information, water seeping from the impoundment is estimated to be as low as pH 2-4 (based on the Ohio Adit water samples). In this pH range, metals would be expected to mobilize and the final seepage water quality is expected to be close to extract values. An estimate of the seepage water quality and the relevant state and federal water quality standards is presented in Table 13.

There are a number of filed water rights claims in area. Approximately half of the claims are for groundwater. It is anticipated that degradation of groundwater, currently claimed, may occur if Impoundment II seeps high rates of polluted water.

The proposal for Impoundment II includes the use of a synthetic liner, and a plumbing system to transport fluids through the embankment face to the seepage collection system. This system controls the phreatic surface within the impoundment. It is anticipated that the effectiveness of this plumbing system would decrease in time. This decrease would raise the phreatic surface and cause drainage through the embankment face. This uncontrolled seepage through the embankment face would be a function of the potential recharge of the tailings. If significant recharge of the tailings takes place, uncontrolled seepage fluids is anticipated.

Table 13. Results of various extraction analyses on the Golden Sunlight tailings material.

Parameter	1980[1]	1984[2]	EPA[3] Acute	EPA[4] Chronic	State Public[5] Water Supply	Irrigation[6]
Cadmium	0.003	0.0000	0.003	0.001	0.01	0.05
Copper	65.2	14.2	0.05	0.03	---	5.0
Lead	0.045	0.33	0.01	---	0.05	10.0
Nickel	0.30	0.71	0.22	4.25	---	2.0
Zinc	1.95	0.35	0.00	0.80	---	10.0
Selenium	1.10	0.01	---	---	0.01	0.02

[1] DSL, Draft EIS - Appendix F

[2] Sample Results Relayed in Letter from Multitech to Darrel Scharf (dated August 28, 1984) Selected portions summarized in Tailings Vegetation reports.

[3] EPA, (1986), Quality Criteria for Water; (EPA 440-5-86-001).

[4] Ibid.

[5] Montana Water Quality, 1984, Prepared by Water Quality Bureau, Environmental Sciences Division, Department of Health and Environmental Sciences, 305(b) Report, October 1984, 19 p.

[6] Ibid.

A mass balance analysis was used to estimate the effects controlling recharge by diversion and topsoil depth in Impoundment II. These results, presented in Figure 6, indicate that the potential recharge can be minimized by increasing the soil replacement depth to 24 inches and diverting runon. The results also suggest that soil depth is more important than a diversion for controlling recharge potential.

The development of Impoundment II, its associated buffer zone and peripheral disturbances, would disturb approximately 1000 acres. This disturbance would result in increased sediment delivery to the Jefferson River during periods of runoff if erosion control measures are not implemented. The company has committed to the use of Best Management Practices to minimize the amount of erosion and sedimentation. The small disturbance area compared to the drainage basin area of the Jefferson River suggests that the potential increase in sediment delivery is minimal.

2. Pit

The proposed amendment would expand the mine pit to approximately 190 acres and extend mining to an elevation of 4800 feet. This elevation is approximately 225 feet below the estimated groundwater table elevation.

Snowmelt, precipitation, and groundwater inflows are expected to result in a standing body of water. This "lake" would depend on the groundwater inflow intercepted during mining. The high evaporation (approximately 42 inches/year) and low precipitation (14 inches/year) in the area suggests that high groundwater inflows would be required to impound water for a significant periods of

time. An estimate of potential groundwater flow in the area is based on 10-20 gpm flows of the Ohio adit.

The pit water quality is expected to be similar to the quality of the Ohio Adit water which is relatively poor. The high net acid production balance for the high wall sample collected in 1983 also supports this speculation. Mine pit water is expected to have a low pH, elevated metals, and high salt concentrations. The evaporation of water would tend to concentrate salts and metals similar to playa deposits in the mine pit area. The composition and thickness of these deposits would depend on the inflow volume and rate. GSM has committed to take whatever means necessary to ensure that no offsite migration of waters occurs.

3. Waste Rock Dumps

The development of the proposed waste rock dumps would affect local runoff patterns. The waste material would alter the local rainfall interception and runoff and may affect very localized aquifer recharge. The areas proposed for waste rock disposal are not major recharge areas, nor do they contribute substantial surface flows in the area. These impacts are anticipated to be insignificant.

Rainfall infiltrating the dumps would either be stored interstitially in the dump material or would flow through as seepage. The current waste dumps have not shown a tendency to seep or affect groundwater in the area due to the free draining nature (size gradation) of the waste material and the effect of high evaporation in the area. The development of the waste rock dumps is not anticipated to affect the local surface and groundwater quality.

4. Cumulative Impacts

The proposed tailings impoundment will be constructed adjacent to the current impoundment. The estimated impacts for the operation and reclamation of the current impoundment is the basis of the cumulative impact analysis.

Final reclamation plans for impoundment I are subject to change pending the result of test plot information. The current test plot design is reviewed in the SOILS section, CHAPTER IV. These studies suggest that a final reclamation proposal will be for six inches of topsoil with no waste rock cap over the unamended tailings.

The potential for seepage from the current impoundment was analyzed using the same methodology as for Impoundment II. The results of a mass balance calculation for Impoundment I are shown in Figure 7. These results suggest that recharge of the tailings is possible under a variety of antecedent conditions. The actual seepage rates were not calculated as part of this analysis. It is anticipated that seepage from the soil horizon would result in recharge of the tailings and eventual seepage from the impoundment.

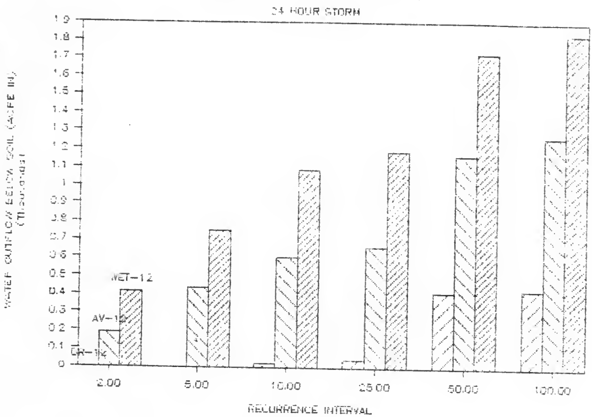

Figure 7. The results of the mass balance calcuations for proposed reclamation plan for impoundment I. The labels "AV-12", "DR-12", and "WET-12" refer to antecedent conditions of average, wet and drought. The value 12 corresponds to a replaced soil horizon thickness of 12 inches.

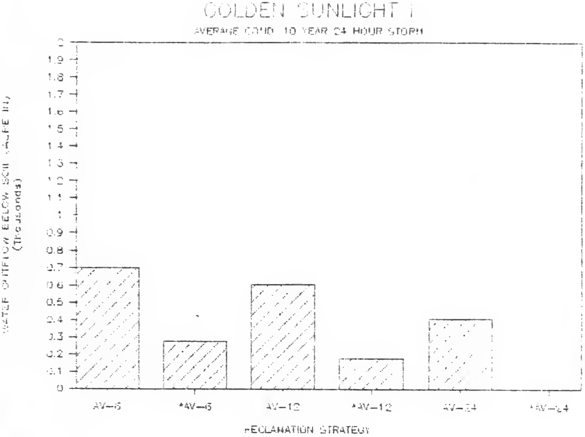

Figure 8. The results of some alternative reclamation strategies for impoundment I using average antecedent values (AV). The values following the "AV" are the replaced topsoil depths (6, 12, or 24 inches). Labels with a preceeding asteric indicate diversion of all upslope runon, values without an asteric assume no diversion.

The tailings placed in Impoundment I is similar to the material slated for placement in Impoundment II. It is anticipated that the pH of the leachate would be low based on the Ohio Adit water samples. Metals would be expected to be mobile in this pH range, and the final seepage water quality is expected to be close to extract values. An estimate of the seepage water quality compared to the relevant state and federal standards is presented in Table 13.

There are filed water rights in the area. Approximately half of those claim groundwater. It is anticipated that degradation of water claimed for a beneficial use in the area may take place if Impoundment I develops high uncontrolled seepage rates of objectionable water.

Impoundment I was designed with an amended soil liner. A piping system was installed above this liner to carry tailings seepage through the embankment face to a collection system. This seepage is currently being returned to the mill circuit. A slurry cut off wall was placed downstream of the impoundment dike to intercept both flow from under the impoundment and seepage through the impoundment liner. An array of pumpback wells upgradient of the slurry cutoff wall intercepts this seepage and underflow. Operational modifications of the impoundment design included additional pumpback wells east and south of Impoundment I. These wells were installed when it was discovered that the slurry cutoff wall was not functioning as designed and seepage was migrating from the impoundment eastward.

It is anticipated that the majority of the seepage from Impoundment I will intercept the slurry cutoff wall. When pumpback is discontinued, both underflow and seepage would create a groundwater mound upgradient of the cutoff wall. Overtopping of the slurry wall will eventually occur if seepage is significant. It is also anticipated that seepage to the east and south may occur. In time, a decrease in the effectiveness of the plumbing system for Impoundment I is expected. This decrease in efficiency may result in a rise of phreatic levels within the impoundment and drainage through the impoundment bottom or through the embankment face.

A mass balance model was used to analyze the effectiveness of alternative reclamation strategies. The results are presented in Figure 8. Results suggest that the probability of seepage from the soil horizon in the impoundments can be minimized by adding a deeper soil horizon and diverting runoff from upslope sources. Recharge of the tailings would occur infrequently if all upslope runoff is diverted and a self-sustaining vegetative community is established on the impoundments. Two feet of soil is recommended to be placed on the impoundment. Model results suggest that diversion of runoff into the impoundment is much more effective at reducing tailings recharge than the addition of deeper soils.

Under the proposed reclamation plans for both impoundments, it is probable that seepage would take place. The additional seepage from Impoundment II to the seepage from Impoundment I would significantly increase the probability of pollutant migration offsite. Assuming a combined seepage rate of 200 gpm and water quality similar to that presented in Table 13, it is likely that local beneficial uses will be impaired.

D. Vegetation

1. Plant community diversity

In the proposed expansion area, another 300 acres of vegetation could be destroyed, affecting fourteen to sixteen of the existing plant communities that were identified in the expansion areas inventories. The total number of acres of vegetation to be destroyed could total over 1500 acres.

Simplification of the physiography and homogenization of the replacement soils would limit the number of plant communities that can be reestablished. The reclamation plan does not address recreation of community diversity. However, the potential does exist to create new communities because of the new substrates, recreated soils and plant species available for reclamation seeding.

2. Plant species diversity

Diversity will be decreased for many years after reclamation. It would increase, but may never approach pre-mining levels. Many of the existing plant species identified in the expansion study areas are difficult and costly to reestablish (Table 8). Topsoil salvage programs would ensure that plant regenerative parts are stockpiled for future replacement on reclaimed sites. But, the potential for most species to regenerate from long-term storage in soil stockpiles is minimal. Over 150 species were found in the vegetation survey. Less than ten are to be reseeded or replanted. The availability of forb and subshrub seed is limiting.

a. Noxious Weeds

The proposed expansion area disturbances would be susceptible to noxious weed invasion from existing sources in the mine area and/or new seed sources introduced during mine life. Eradication may be impossible. An aggressive weed control program has been implemented but as the size of the disturbance increases, effectiveness diminishes.

Weed control programs to control the aggressive species found on the mine site result in the destruction of many native forbs and shrubs susceptible to the control method used.

In combination, the weed control program, seeded aggressive introduced species, and in particular the noxious weeds, operating in the absence of natural plant predators and pathogens, have the potential to displace native species, and eventually produce a disclimax. The number of forb and shrub species would be especially limited.

3. Plant Forage and Shelter for Livestock and Wildlife

The continued expansion of the mine would displace livestock and wildlife that used the expansion areas for food and shelter. Eventual revegetation of the disturbed acres would lessen the long-term impact.

Revegetated communities on mines can typically return to pre-mine productivity levels but plant diversity is decreased, limiting the utilization by certain classes of livestock and/or wildlife (DePuit, 1988). But, GSM has proposed replacing only 6 to 12 inches of soil over waste rock on the second tailings impoundment. This would result in lowered productivity of the reclaimed impoundment area because the majority of the original soils that exist under the proposed impoundment site are much deeper and well drained. GSM proposes to replace even less soil over the first impoundment reclaimed surface. Production potential is reduced even more than on the second impoundment, unless the tailings are amended sufficiently to reduce acidification and other chemical and potential physical limitations.

4. Revegetation Potential

Over the entire mine site, some acres may not revegetate in the short term due to rock content and a lack of cover soil. Conversely, some acres may revegetate and subsequently fail in the long term due to potential acidification in the waste rock dumps and/or tailings impoundments, or other toxic or limiting physical and chemical properties in the waste rock or tailings.

In the proposed amendment, the potential for acidification of the oxygenated areas of the waste rock dumps could not be evaluated because of insufficient data. However, GSM is required to develop acid-base data for the waste rock types. Potential acidification is less for the waste rock dumps than for the tailings impoundment because of the reduced surface area exposed due to rock content.

The tailings reclamation test plots established in 1985 indicate that revegetation is possible in the short term on topsoiled tailings that were fertilized with nitrogen, phosphorus and potassium and amended with elemental sulfur to reduce the reaction (pH) and reduce the sodium (Na) hazard inherent in fresh tailings. The final report on the tailings study plot indicates the reclamation methods tested to date would fail in the long term due to acidification of the reactive tailings (Western Reclamation, Inc., and GSM, 1989, 21 p.).

DSL has asked for a capillary break on the second impoundment to ensure the replaced cover soil and reestablished communities have at least 6 to 12 inches of good soil to survive. Without the capillary break of waste rock, if the tailings did acidify or the cover soil was contaminated by acid and/or sodium, the vegetation would be subsequently destroyed and a tremendous potential for wind and water erosion would be created.

5. Erosion Potential

The additional acres to be disturbed would increase the potential for wind and water erosion during the mine life. Dust would coat vegetation in the surrounding plant communities, especially those close to access and haul roads.

Various techniques have been used at the mine to limit dust problems and ensure compliance with their air quality permit. Increased waste to ore stripping ratios and increased hauling distances would increase dust production.

The greatest potential long-term impact of wind erosion would occur if, after the reclamation plan on the first tailings impoundment is implemented, the reestablished vegetation died, re-exposing the minimal cover soil and tailings to wind (and water) erosion. This is particularly significant on the cycloned sands dam embankment face. Erosion of the dike face must be minimized.

Significant runoff could occur from the disturbed sites during a major storm event unless GSM continues to implement Best Management Practices (BMP's) to reduce erosion and disperse runoff. As the size of the disturbances increases, especially in critical drainageways, the runoff hazard increases and factors such as culvert sizing and the need for diversions must be reevaluated.

6. Aesthetic Impacts

Vegetation tends to soften the appearance of unweathered rock. Concurrent reclamation would probably not be possible. The destruction of vegetation would adversely affect the visual quality of the mountain setting from Whitehall, Cardwell, and the major highways in the area.

E. Wildlife

The local elk herd should not be much impacted by the expansion of waste rock dumps and the construction of the proposed tailings impoundment. The major dislocation which occurred in 1981 removed wintering elk a sufficient distance northward to avoid further disruption from the proposed activity. It is possible that some summer use areas nearer the mine may become insecure to individual animals.

Mule deer which have become acclimated to the mining operation nearby would be physically displaced by the advancing waste rock dumps and by construction of the new tailings impoundment. These animals would move to less desirable habitat or to areas already occupied. This displacement would be gradual and major population fluctuations would probably not be observable. Deer would probably continue to frequent the edges of the operation. Occasional loss of a deer in the tailings impoundment is a possibility.

The antelope which winter south of Red Hill, and the 20 to 30 animals which summer in this vicinity would be affected by a direct loss of forage as a consequence of construction of the proposed tailings impoundment. It is unlikely that the loss of approximately 500 acres would materially diminish the forage base for these animals. Displacement to adjacent areas is likely if tailings impoundment construction results in loss of important habitat components or disturbance.

Most of the small mammals occurring in the expansion areas are incapable of making rapid, long distance moves. Hence, those chipmunks, mice, voles, ground squirrels and other small species which are in the path of advancing dumps or earthmoving equipment would be covered by soil and debris or be caught under machinery. Coyotes, bobcats and other species capable of long-distance flight would probably escape and attempt to relocate in other areas. These

populations are not unique to the disturbed acres, hence their loss would have no effect on adjacent areas.

Proposed mine expansion would have no direct effect on waterfowl. However, construction of an additional tailings impoundment, more than doubling tailings acreage, would increase the potential of loss of birds which settle on the ponds. Three swans died last year on the tailings ponds despite the deterrent efforts of Golden Sunlight.

There is a remote possibility that acid tailings leachate might at some time reach the Jefferson River. This leakage, if it occurs, would probably not occur until after reclamation efforts have begun, and possibly not until many years later. Volumes and toxicity of any leachate is not quantifiable at this time. If leaching did occur, and if it reached the Jefferson, it is unknown whether concentrations in the river would cause any fish mortality, but salmonid (trout) fish species are very sensitive to cyanide and metal-complex concentrations in water. The Jefferson does experience severe dewatering on this stretch of river at times.

Long-term consequences would depend to a great extent on the success of reclamation. As the waste rock dumps revegetate, they would again provide habitat for wildlife. Cover would be sparse and lacking diversity in comparison to the pre-mine condition. The topography would be homogenized and would offer fewer sites for establishment of habitat diversity. Nevertheless, it is expected that mule deer would begin to frequent the reclaimed waste rock dumps as mining ceases.

Elk would also be expected to return to the vicinity, even though the dumps themselves would not meet many of their habitat needs. Small mammals would reinvade revegetated areas from undisturbed edges.

If reclamation of the proposed new tailings impoundment is successful, the reestablished grassland would provide usable forage for antelope which have historically used the area. Small mammals would gradually invade from peripheral areas. The level of productivity, cover and species diversity is unpredictable, but can be assumed to be less than native range in good condition.

If reclamation of the waste rock dumps is ultimately unsuccessful, then they would provide little usable habitat for any wildlife species.

The first impoundment reclamation presents some special problems. Initially, the pond would be a toxic, slimy pond creating a hazard for mammals and waterfowl. After drying, the tailings would no longer be a hazard to waterfowl. Reclamation of the existing tailings pond would almost certainly fail as presently proposed. The dry blowing tails would not be usable for any wildlife species.

Threatened and endangered species are not expected to be impacted by the proposal. The possibility of eagles feeding on killed waterfowl on the tailings ponds is remote, given the efforts of Golden Sunlight to prevent waterfowl from landing on the ponds.

F. Air Quality

1. Direct

The primary air pollutant of concern with the expanded project is particulate matter (dust). The following table lists the estimated particulate emissions for the project as shown in Golden Sunlight's air quality permit (No. 1689A).

Table 14 - Particulate Emission Inventory

	Tons/Year	
Source	Uncontrolled	Controlled
Pit Operations		
Topsoil Removal	1.24	1.24
Drilling	18.8	9.38
Blasting	6.25	6.25
Ore Removal	13.0	13.0
Waste Removal	74.5	74.5
Hauling	476.0	238.0
Road Maintenance	53.0	35.0
Ore Dumping	13.0	13.0
Waste Dumping	74.5	74.5
Equipment Exhaust	6.37	6.37
Tailings Disposal Operations		
Topsoil Removal	21.5	21.5
Exposed Tailings	32.5	8.13
Miscellaneous		
Exposed Areas	12.6	12.6
Borrow Areas		
Pit		
Dumps		
Haul Roads		
Access Road		
Parking Lot		
Plant Lot		
Access Road Traffic	215.0	32.3
Secondary Crusher Venturi Scrubber Stack		
Primary Crushing	26.0	0.26
Secondary Crushing	32.5	0.33
Tertiary Crushing	19.5	0.20
Coarse Ore Conveying and Reclaiming	6.5	0.07
Coarse Ore Stockpile Discharge	6.50	3.25

Fine Ore Stockpile Discharge	13.00	6.50
Mill Scrubber Stack	13.00	0.13
Fine Ore Reclaiming and Conveying		
Carbon Regeneration Scrubber Stack	6.6	0.9
Refining Furnace Scrubber Stack	1.9	0.4
TOTAL	1,143.8	557.8

The following table lists the estimated gaseous pollutant emissions from the project.

Table 15 - Estimated gaseous pollutant emissions from Golden Sunlight Mine.

Source	Tons/Year Controlled
Equipment Exhaust	
SO_2 (Sulfur Dioxide)	11.2
CO (Carbon Monoxide)	44.5
HC (Hydrocarbons)	7.5
NO_x (Nitrogen Oxides)	103.0
Blasting	
SO_2	4.52
CO	151.3
NO_x	38.4

The emission control practices used by Golden Sunlight have been determined to represent Best Available Control Technology (BACT) for this project by the Montana Air Quality Bureau.

2. Indirect

There would be a slight increase in air pollution levels associated with any population increase in the area. This results from increased vehicle traffic and home heating.

3. Cumulative

The Golden Sunlight mining operation is the only large industrial source of air pollutant emissions in the area currently and no others are anticipated in the near future. The cumulative or additive impact of these emissions with the existing or possible future minor sources in the area should be minimal. Concentrations of all air pollutants should remain well below ambient air quality standards.

In general, particulate emissions would increase with time as the mine expands. This is related to increased haul distances and exposed areas (disturbance areas and tailings). At the conclusion of mining, corresponding air pollution sources would no longer exist assuming successful reclamation.

G. Transportation

Vehicle access to the mine would not be affected by the proposed expansion of the waste dump and construction of new tailings impoundment. Access from the Interstate would continue to be via the Cardwell interchange, through Whitehall on Highway 2, or from Highway 2 and Highway 69 toward Boulder and Helena. The increase of approximately ten workers per shift is not anticipated to result in a noticeable increase of traffic on local, state or federal highways.

H. Socioeconomics

The proposed expansion would increase the work force by 25 to 35 additional employees. GSM has committed to hire as many local, qualified people as possible and has approximately 400 job applications from the local (Whitehall, Cardwell and Silver Star) area.

The proposed disturbance areas would result in a change in land classification from agricultural to industrial and a higher county property tax bracket. Along with increasing the taxable valuation of the land, Golden Sunlight would increase the number of off-road ore haulers used at the mine by five. These vehicles would be taxed as personal property by Jefferson County and would increase the amount of tax paid by the company.

I. Cultural resources

Expansion of the waste rock dump would include portions of the west half of Section 20, T2N, R3W. The disturbance area would not extend to the site of 24JF292 on Sheep Rock. The cultural materials exposed by the cut face in the road to the spring have been protected by burial as a result of the annual inspection in 1988 conducted by DSL personnel. A layer of plastic sheeting was anchored to the site, and it was covered by talus from an adjacent location. As a result, expansion of the waste dump to the west side of the drainage should pose no threat of direct or indirect impact to the site. Should Golden Sunlight, at a future time, propose to disturb the site, full mitigation measures would be required in accordance with the conditions of the MOU.

Site 24JF766 would be obliterated by construction of the proposed tailing impoundment dam, either of the dam itself or borrow areas utilized for dam construction. The site has been photographed, mapped, and recorded and no further work was recommended.

J. Aesthetics

During the active mining operation, the enlarged pit, proposed dumps and tailings impoundment would contrast with the natural landscape in both form and color. The mine would be visible from the communities of Whitehall and Cardwell, as well as the interstate, and local highways.

After reclamation, contrast with form and color would continue. The geometric form of the reclaimed dumps and dam, and the artificial flatness of the tailings impoundment surface would continue to contrast with the steep

natural topography of the surrounding area. As weathering reduces the lighter color of exposed rock on the pit wall and dump surfaces, the predominant color would fade from light grey to rusty brown. As vegetation becomes established, the color of reclaimed surfaces may blend with nearby undisturbed habitats, particularly in early spring before droughty conditions of replaced soil accelerate vegetative curing.

CHAPTER V CONCLUSIONS AND RECOMMENDATIONS

A. Reclamation of Reactive Wastes

Weathering of sulfide-bearing wastes produces sulfuric acid, which lowers the pH and solubilizes residual heavy metals. Acid formation is controlled by mineralogy, oxygen transfer, water quantity, water movement through the wastes, bacterial growth, and particle size distribution. Acidic leachate, or acid mine drainage (AMD), may be produced that is both deleterious to ground and surface waters and toxic to vegetation (CANMET, 1988, 72 p.).

Sulfide-bearing wastes that are acid generating can be successfully revegetated and acidic leachates controlled by 1) limiting oxygen penetration, 2) water movement through the waste materials, and 3) acid and metals accumulation in the root zone of vegetation. Diversions are used to limit overland flow and water accumulation on the reclaimed surface. Establishment of vigorous vegetation and an adequate rooting zone prevents the recharge of waste material by eliminating the potential for water moving through the plant growth medium in all but major moisture events. The reclaimed surface may be modified to limit concentration of water on any one area on the reclaimed surface. Neutralization of acid tailings or construction of a capillary break, or other barrier prevents contact of rooting vegetation with acid generating materials.

Vegetative cover over reactive sites would eventually acidify, destroy the reclaimed soil and vegetation, and produce acidic leachate, unless the tailings and/or waste rock are amended to produce an effective plant growth medium or the sulfide-bearing wastes are isolated through the use of various covers and/or barriers.

1. Tailings Reclamation

Dry barriers over reactive tailings often consist of engineered covers of waste rock, soil, clay, till, polymer/synthetic membranes or cementitious materials that create a hardpan and/or capillary break over the wastes. These covers can be designed to control oxygen penetration and water movement into the wastes.

In semi-arid or arid climates, these covers can be designed to isolate the replaced rooting media from eventual contamination from upward migration of acid or other chemical properties (i.e. sodium) from the reactive tailings.

2. Waste Rock Reclamation

Surface area exposure is directly proportional to oxidation rates of pyritic wastes. In addition, the potential for acidification of waste rock is reduced in arid climates. Golden Sunlight Mine dump material is primarily coarse and the area is semi-arid. Under such circumstances chemical amendments of the surface waste rock and/or resoiling may be all the treatment needed.

Treatments commonly applied to waste rock to limit acidification potential

include blending with alkaline materials, segregation and separate treatment of acid wastes, cellular dump construction, and treatment with alkaline water. Dry covers used most frequently to cap waste rock include compacted clay, soil, till, polymer/synthetic and/or cementitious materials.

3. Acidic Leachate Treatment

Chemicals and bactericides are used to control acid mine drainage during the operational phase. Long-term treatment techniques being used include lime neutralization, sodium hydroxide and sulfide precipitation, ion exchange, reverse osmosis, biotechnology, and others. The sludges produced in the treatment phase present a disposal problem, and these methods for the most part require long term maintenance.

B. Impact Summaries and Mitigations

1. Geology

Assuming that mining through Stage V is completed, mass instability of the waste rock dumps or tailings impoundments is not anticipated after mine closure and completion of reclamation.

Limited data shows waste rock and tailings at the Golden Sunlight Mine are acid-generating. The distribution of acid-generating potential in waste rock and the tailings is unknown. Therefore, effective reclamation requirements to ensure successful revegetation and long-term water management cannot be specifically evaluated or identified. The department, as a condition of Amendment No. 006, has required GSM to conduct a detailed evaluation of acid-producing potential and toxicity of the pit, waste rock, and pit water through Stage III mining.

> Mitigation: The evaluation of acid-producing potential and toxicity of Golden Sunlight Mine wastes should be expanded to Stages IV and V mining and include both tailings impoundments. GSM should prepare a sampling program for the department's approval that would adequately characterize acid-generating potential and toxicity of the waste rock, tailings, and pit wall. This information would be used to identify the most inert rock for constructing a textural break and determining adequate neutralization rates for waste rock dumps and tailings impoundments. Further, the study should evaluate the tailings texture and chemistry, and various amendment strategies, including depth of incorporation and/or rock cap thickness requirements.

2. Hydrology

Long-term water treatment requirements are greatest for the present and proposed reclamation plans than for alternatives that incorporate water diversions, textural rock breaks, tailings neutralization, and maximize soil replacement depths (up to 24 inches) for reclamation of the tailings impoundment.

The proposed reclamation plan for Impoundment II has potential for producing acidic leachate.

> Mitigation: Replacement of more soil than proposed on both impoundment surfaces, combined with diversion of upslope runon water would significantly reduce the potential for recharge of the tailings.

A cumulative impact analysis suggests that the proposed reclamation plan for Impoundment I has a greater potential to produce acidic leachate than Impoundment II.

> Mitigation: Vigorous vegetative growth over deep soils protected from acidification by neutralization and/or textural break, and diversion of upslope runon, would provide the greatest reduction in potential recharge and acid leachates.

3. Soils

a. Tailings Impoundment II

Reclamation of tailings Impoundment II would be successful if acidification from or through the waste rock textural break does not develop. An excessive amount of soil may be lost to voids in the textural break which would greatly diminish vegetative production and cover due to the thin layer of remaining soil, reducing the probability of revegetation success.

Mitigations:

1) Use of waste rock with low acid-generating potential would reduce the potential for acidification of cover soil over the waste rock. Expanded monitoring of acid-generating potential of waste rock would provide essential data to select suitable quality waste rock for tailings capping.

   Complete soil salvage from Impoundment II would allow the replacement of more than two feet of soil, greatly increasing the probability of successful establishment of a vigorous, productive plant community. A greater soil thickness would also reduce water recharge of the tailings by storing water and promoting a more vigorous plant community for evapotranspiration reducing the potential of acid leachate development.

   Complete soil salvage for Impoundment II should be done in two lifts, segregating approximately 6 inches of topsoil from subsoils. Direct haul replacement where possible would enhance the probability of revegetation success.

2) Lime or other amendments would neutralize waste rock used as a textural break. Neutral waste rock or rock with a base potential from a nearby source could be used to simultaneously provide a textural break and reduce the potential for acidification from the tailings.

3) Complete soil salvage would result in salvage of calcareous soils which may limit the need for additional amendments.

4) Use of a filter fabric over the tailings and beneath the waste rock, would prevent mixing of the rock and tailings, and subsequent contamination of the replaced soil.

5) Rock capping of the dike would protect against potential acidification of replaced soils and rill and gully erosion of the dam face that would cause on-going revegetation failures.

b. Tailings Impoundment I

Successful long-term reclamation of the tailings Impoundment I is unlikely. Soil acidification from contact with the tailings, possible upward migration of salts and sodium, coupled with a thin layer of cover soil make revegetation failure inevitable.

Mitigations:

1) Complete soil salvage on Impoundment II would salvage sufficient soil to allow coverage of Impoundment I with more than two (2) feet of soil. This would greatly improve the probability of revegetation success by providing an adequate rooting medium. The calcareous soils may serve to partially neutralize acid tailings. Direct haul replacement, where possible, would enhance probability of revegetative success.

2) Coverage of Impoundment I with a capillary break, as described for Impoundment II, would prevent the acidification of soils from contact with tailings and the upward migration of salts and sodium.

3) Use of lime rock or neutral waste rock for the capillary break would minimize acidification of the soil.

4) Amending the tailings with gypsum or other amendments may ameliorate the negative properties of the tailings surface.

5) Rock capping of the dike would protect against potential acidification of replaced soils and rill and gully erosion of the dam face that would cause on-going revegetation failures.

c. North Waste Rock Dumps

Soil coverage is probably sufficient to allow establishment of self-sustaining vegetation on the north waste rock dumps, if erosive loss is not excessive. There will undoubtedly be loss of soil to erosion and some resulting areas of bare rock. If the waste rock proves to be acid producing, vegetative failure and concomitant loss of soil can be expected.

Mitigations:

1) Complete soil salvage under the north waste dump would allow for a replacement depth of 36 inches on dump tops and slopes, greatly improving the probability of successful establishment of a vigorous, self-sustaining vegetative community.

2) Lime or other treatment of the rock dumps would alleviate acidification potential.

d. South and West Side Waste Rock Dumps

Proposed replacement soil is barely adequate to establish vegetation. There would be large areas from which soil would be lost leaving bare rock exposed. Revegetation would be patchy, at best. If acidification affects the soil cover, complete revegetation failure and subsequent loss of soil may be inevitable.

Mitigations:

1) Complete soil salvage on the west side would allow for a replacement soil depth of 19 inches on dump tops and slopes. This would improve the chances of successful revegetation.

2) Lime or other treatment of the rock dumps would alleviate acidification potential.

4. Vegetation

Mining disturbance would affect plant community diversity and plant species diversity in the following general ways. Accordingly, mitigations are proposed to ameliorate these impacts.

a. Plant community diversity

A number of existing plant communities cannot be recreated. The reclamation plan does not address community diversity. Simplifying topography and blending soil horizons decreases the potential number of communities that can be reestablished. Some new plant communities can be reestablished.

Mitigation: Variety in plant community reestablishment can be enhanced by selective placement of the final layers of waste rock parent materials and/or cover soil textures and depths. The reclamation plan can be enhanced and seed mixes can be designed to recreate different plant communities dominated by various mixes of grasses, forbs, shrubs and trees specifically designed for various slopes, exposures, elevations and dominant soil texture.

b. Plant Species Diversity

The number of plant species will decrease because 1) replacement species are limited, 2) reproductive tissues in soil stockpiles will die, and 3)

species would be lost due to displacement by aggressive seeded, introduced species, noxious weeds, and weed control. The number of forbs and shrubs would be impacted most. Some new species would be introduced in reclaimed plant communities.

> Mitigation: Species diversity can be enhanced by various establishment techniques such as direct haul soil replacement in appropriate seasons, specially designed seed mixes eliminating aggressive species that tend to out compete natives, establishment irrigation, direct transplantation of certain species, greenhouse establishment of woody plants from seed or cuttings.

c. Forage and Shelter for Livestock and Wildlife

Potential forage production and species diversity would be reduced in the reclaimed areas, particularly on the shallow soils replaced over the tailings.

> Mitigation: Careful planning of new disturbances would allow direct haul soil replacement to disturbances ready for reclamation. Concurrent reclamation of any disturbances would help limit displacement of animals. Use of improved rangeland forage species would enhance forage production of grasses and legumes benefiting certain classes of livestock and/or wildlife.

d. Revegetation Potential

Revegetation is limited by the potential for acidification of soil which would result from the proposed reclamation plan on Impoundment I. Potential replacement value of the sub-soil resources have been misinterpreted. Shallow soils would limit vegetative cover and production.

> Mitigation: Adequate supplies of salvageable sub soils exist in the proposed expansion area to augment the limited supply of soil that has been salvaged to date at the mine. The revegetation potential of all areas at the mine increases with increasing replacement soil depths.

e. Erosion Potential

Wind-blown dust would increase with expansion of soil stripping operations and dump expansion. Erosion on the waste rock dumps would limit revegetation.

Significant failure of revegetation on tailings Impoundment I would cause visible dust and tailings disposition on adjacent areas. Revegetative failure would also result in development of rills and gullies on the embankment faces of Impoundments I and II.

Mitigations that would reduce wind and water erosion are identified in Soils and Hydrology sections, and elsewhere in the revegetation section.

C. Recommendations

GSM proposes to reclaim about 2,421 acres of mining disturbance at the end of mining Stages I through V. Final reclamation activities may require three to five years to accomplish after mining ends in 2005. Many more years of monitoring would be required before it would be learned whether or not GSM achieved the stated reclamation objectives to "prevent contamination of water and soil through erosion of tailings by wind and water, and to accelerate the reestablishment of self-sustaining ecosystem..." or whether state air and water quality standards can be met.

After reclamation, GSM would monitor revegetation of the reclaimed surface disturbances, as well as surface and groundwater downgradient and within the mine permit area. GSM would implement remedial actions if monitoring showed poor revegetation or water contamination. GSM has committed to numerous remedial actions, such as additional seeding and planting, rock surfacing, and water treatment if monitoring showed that the objectives of the reclamation plan or state standards were not being met. Presumably, any remedial actions necessary to meet the reclamation objectives and state standards would continue to be implemented by GSM as long as monitoring demonstrated the need.

GSM's commitment to monitor and take appropriate remedial actions clearly recognizes the potential for acid-producing wastes to contribute poor quality leachate to groundwater and cause failure of revegetation. GSM speculates that results of on-going vegetation test-plots and initial reclamation of impoundment I, prior to reclaiming Impoundment II would provide site specific data to refine reclamation procedures that would avoid poor quality seepage and revegetation failure.

Regardless of GSM's commitments to monitor and take appropriate remedial actions, reclamation will likely fail, particularly for the mine as a whole. In a reasonable worst-case scenario, reclamation failure would degrade water sources downgradient of the mine, cause noticeable dust from the mine area, create an unnaturally erosive and highly visible land surface, and permanently remove up to 2400 acres of vegetation and wildlife habitat from future livestock and wildlife uses. The impacts would be long term and future rehabilitation costly. Limited soil resources at the mine site would require that suitable soils be imported to replace soils contaminated by acid and metals.

The following measures would improve success of reclamation of the acid-generating wastes and reduce environmental impacts to acceptable levels.

1. Golden Sunlight Mines, Inc. (GSM) shall systematically sample and analyze mine waste rock through Stages IV and V according to Acid Producing Potential Sampling and Analysis Plan submitted February 28, 1989 and approved March 10, 1989.

   In addition, GSM shall submit within 90-days of issuance of this amendment for Department approval a sampling and analysis plan to determine acid producing potential and toxicity of tailings for the

existing and new tailings impoundments. GSM shall implement the approved plan.

2. Using test data from the sampling and analysis plans described in Stipulation 1, GSM shall (1) estimate adequate application rates to neutralize acid-generating waste rock and tailings, and/or (2) identify and prepare a plan for the use of neutral or near-neutral waste rock suitable for covering acid waste rock and for constructing a textural break between soil and acid tailings. GSM shall compile, evaluate, and report data for DSL approval.

3. GSM shall use the quantity of lime approved by DSL as adequate to neutralize tailings, or place over the tailings of Impoundments I and II a rock cap of two (2) feet thickness of waste rock to separate soil from acid-generating tailings and function as a textural break to prevent upward migration of acid, salts, and metals.

4. Before redistribution of soil on Impoundments I and II, acid-generating waste rock used for rock capping must be neutralized with adequate amounts of lime, otherwise treated, or covered with base potential rock in a manner approved by DSL.

5. On waste rock dumps, GSM shall use a quantity of lime approved by DSL as adequate to neutralize acid-generating waste rock before redistribution of soil, or place over the acid-generating waste rock a layer of neutral rock adequate to serve as a textural break.

6. Before covering the dam faces with soil, GSM shall provide a two (2) foot waste rock cap on the dam faces of Impoundments I and II. Acid-generating waste rock must be neutralized with adequate amounts of lime, or otherwise treated in a manner approved by DSL.

7. GSM shall construct a final reclamation surface for Impoundments I and II so that a minimum gradient of 1/2 percent is achieved to direct precipitation runoff away from the dam (to the north). Any rock cap placement must account for differential settlement of the dewatered slimes, and must incorporate the use of stabilization filter fabric where necessary to allow reclamation equipment access and protect the rock cap from mixing or contamination by tailings material during placement of the rock cap.

8. GSM shall construct runoff diversions as described in SHB Job Nos. E81-41 and E87-13 upslope of Impoundments I and II at the end of impoundment use to eliminate surface water runon and recharge of tailings and protect revegetation from slopewash erosion.

9. GSM shall salvage 1,355,000 million bank cubic yards (bcy) of soil from Impoundment II. Soil must be salvaged in two (2) lifts from Impoundment II, segregating approximately 6 inches of topsoil from subsoil. Salvaged soil from Impoundments I and II, totalling 1,452,000 million bcy, must be replaced over Impoundments I and II in two horizons to a depth of twenty-four (24) inches.

10. GSM shall salvage 1,081,000 million bcy of soil from the south and west waste rock dump areas to provide nineteen (19) inches of replacement soil for reclamation and shall use this soil for reclamation of these areas.

11. GSM shall salvage 1 million bcy of soil from the north waste rock dump area to provide twenty four (24) inches of replacement soil for reclamation of this area.

12. GSM shall notify DSL at least 48 hours before beginning soil salvage operations for each waste rock dump expansion and Impoundment II.

13. GSM shall submit semi-annual soil salvage status reports that include information required by DSL. GSM shall also submit results of on-going test plot reclamation studies for tailings.

14. GSM shall submit for Department approval final design specifications to implement the reclamation plan and approved stipulations. GSM shall implement the reclamation plan and approved stipulations.

These measures, in addition to GSM's mining and reclamation plan would mitigate the potential impacts of the company's proposal below the level deemed significant by DSL. These measures, if made conditions of the Department's approval, would make unnecessary the preparation of an EIS.

CHAPTER VI - CONSULTATION AND COORDINATION

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